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REPORT OF CHIEF OF BUREAU OF BIOLOGICAL SURVEY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., September 1, 1928.

SIR: I have the honor to transmit herewith a report on the work of the Bureau of Biological Survey for the fiscal year ended June 30, 1928.

Respectfully,

PAUL G. REDINGTON,
Chief.

Hon. W. M. JARDINE,
Secretary of Agriculture.

WILD LIFE RESEARCH AND ADMINISTRATION

Research, service, and regulatory functions with regard to wild life embrace all the varied operations of the Bureau of Biological Survey. In these three branches the bureau has enjoyed continued cordial relations with scientific institutions and individual research workers; with officers of State departments of agriculture, extension services, livestock and other associations, cooperating stockmen, and farmers; and with State conservation departments, the Alaska Game Commission, sportsmen's associations, hunting clubs, and individual sportsmen and other conservationists. Through the interest of cooperators in the varied duties assigned to the Bureau of Biological Survey, the influence and helpfulness of the bureau is greatly extended, far beyond the sphere of activity of the limited force of workers that can be carried on its rolls.

Fundamental to all other functions of the bureau is the important branch of research. The scientific investigations of the survey cover studies of the distribution and habits of wild-life forms, their economic status as determined by food and feeding habits, the conservation and propagation in captivity of useful wild mammals and birds, and methods of reducing the damage wrought by predatory animals on livestock and on game and other useful species, by rodents on farm and forage crops, and by other forms that are otherwise economically injurious. The importance of extending the research work of the bureau can not be too strongly stressed. Without it, the service expected by the public and by the various States in advice and coordination of effort in wild-life conservation, utilization, and control can not be properly rendered.

Dependent upon the research work of the bureau and developing from it is the branch of service, the activities of which consist for the most part in disseminating the information gathered; work for the benefit of the public, not primarily involving research, described as wild-life control, either in independent operations on public domain or in organized campaigns conducted cooperatively with State, Territorial, or other agencies; and wild-life conservation through the administration of bird refuges and big-game preserves.

The future enjoyment of wild-life resources is dependent upon the administration of conservation laws and related regulatory and educational activities. The laws administered by the Bureau of Biological Survey, through the preparation and enforcement of regulations, include (1) the migratory bird treaty act, (2) the Lacey Act, regulating interstate com-

merce in wild-life forms and their importation from foreign countries, (3) the act protecting wild life and property on game and bird reservations, (4) the upper Mississippi River wild-life and fish refuge act, (5) the Bear River migratory bird refuge act, (6) a section of the tariff act of 1922 (sec. 1569) authorizing regulations to control the importation of eggs of game birds, and (7) the Alaska game law, through representation on and cooperation with the Alaska Game Commission.

ORGANIZATION CHANGES

Just before the close of the year a reorganization of the activities of the bureau on conservational lines was effected in the consolidation of the division administering game and bird reservations and Alaskan wild life with the division of migratory-bird treaty and Lacey Acts administration. The new division of game and bird conservation is under the leadership of H. P. Sheldon, formerly in charge of the latter division. His title has been changed from chief United States game warden to United States game conservation officer. The change in administrative direction permits the assignment of E. A. Goldman, formerly in charge of the reservations division, to research work, to continue scientific investigations that had been interrupted by administrative responsibilities. The wardens of the two former divisions will now be known, respectively, as United States reservation protectors and United States game protectors, but cooperating State and other officials detailed to enforcement of the migratory-bird treaty and Lacey Acts will still be designated United States deputy game wardens. The change in organization was made with a view to preventing what was seen to be a tendency toward overlapping of functions of the two divisions, and will be in the interest of better correlation of the work of the bureau and of greater efficiency and economy, particularly in the further development of the migratory-bird refuge program.

A further change in leadership within the bureau was brought about on February 16, 1928, when A. K. Fisher, connected with the Bureau of Biological Survey ever since its organization in 1885 and since 1909 in charge of the division of economic investigations, was assigned to scientific work to round out material on the economic status of hawks and owls, a subject on which he has long been a recognized authority. He was succeeded by Stanley P. Young, by transfer from active predatory-animal field operations in Colorado, and for the past year assistant in the direction of the division. W. E. Crouch, for 12 years a leader in rodent-control operations in Idaho, was brought to Washington to assist Mr. Young.

CHIEF ACCOMPLISHMENTS OF THE YEAR

Among the landmarks placed during the year that indicate definite accomplishment in wild-life administration or forward-looking legislation to promote conservational programs, may be mentioned the following, the details concerning which are set forth in this report, together with the urgent need for still greater constructive advance:

Inauguration of studies of changing abundance of migratory wild fowl from year to year, through systematic and repeated censuses taken by cooperators of the Bureau of Biological Survey on important concentration areas.

Authorization by congressional legislation of more extended research having to do with the relations of wild life to forestry—the effects of birds, mammals, and other forms on forest production.

Successful crossbreeding of Alaskan reindeer with native caribou captured for the experiments, and the birth of fawns of materially increased weight.

Progress in research work on the food of the English sparrow through the completion of examination of thousands of stomachs collected throughout the country, the first stage necessary to the preparation of a final report.

Establishment of the rabbit experiment station in California to supplement other investigations on the production of rabbits for fur and food.

Definite progress through cooperative effort in investigations of diseases of foxes and measures for their prevention and cure on fox farms.

Development, through a conference of field leaders in rodent and predatory-animal control at Ogden, Utah, of improved plans for research work and definite policies in local and general control operations. Congress requested that there be submitted to it at the next session a plan that will operate to insure adequate control of the predatory animals throughout the country.

Authorization by Congress of a refuge for migratory birds in the extensive Bear River marshes, Utah, and first steps in its administration, as an aid to conserving the wild-fowl resources of the West.

Greater expedition in the work of acquiring lands for the upper Mississippi wild-life refuge through congressional aid and through private donation of areas important to the purposes of the refuge.

Definite progress in studies of the requirements of the Wyoming elk, in the administration of other game animals and birds on reservations, and in coordination of State and Federal policies in wild-life administration generally.

The development of additional refuge areas for wild life has been brought more intimately to public attention, and the sentiment throughout the country is more definitely crystallized in favor of a unified program, as it becomes generally understood that the onward march of civilization, with its farming and industrial operations, threatens at least locally the ultimate extinction of the various forms of wild life that were the delight of our forbears and that can not be perpetuated for future enjoyment unless provided with free range, including feeding, breeding, and resting grounds.

BIOLOGICAL INVESTIGATIONS AND LIFE-HISTORY STUDIES

Research is an absolute essential to progress in wild-life administration. The Federal Government alone can not be depended upon to solve all the problems involved. Cooperation of all agencies—States, Federal bureaus, associations, and individuals—to provide reliable and specific facts for long-time programs of conservation is a very definite obligation. All problems affecting wild-animal life should be considered not alone from the standpoint of the present but of future generations. Constructive programs must be put into effect that will make available to all the people the wholesome influences of the great outdoors, including the stimulus of wild-life association. During the past year particularly important progress has been made in projecting clearly defined plans of research to these ends, and in enlisting the cooperation of organizations interested in these undertakings.

INVESTIGATIONS OF WILD FOWL AND BIG GAME

WATERFOWL CENSUSES

The response made by observers throughout the country to the appeal of the bureau for assistance in gathering more complete information regarding the abundance, distribution, and movements of waterfowl has been most gratifying. More than 3,000 observation stations have been established, representing every State in the Union and all the Provinces of Canada, as well as Alaska and Porto Rico. Reports from these stations are made by volunteer observers on selected dates once each month, each giving results of actual field observation on a waterfowl-resort area typical of the region. Cooperation has been obtained from virtually all State game and conservation commissions, chiefly through their warden forces; from Canadian authorities, through cooperation of the Office of National Parks of Canada and game officials of the Provinces; from sportsmen's and conservation organizations; and from individuals. Federal bureaus include the Forest Service, the Weather Bureau, and the Extension Service of the Department of Agriculture, the National Park Service, the Office of Indian Affairs, the Bureau of Reclamation, and the Bureau of Education of the Department of the Interior; the Bureau of Lighthouses and the Bureau of Fisheries of the Department of Commerce; the Coast Guard of the Treasury Department; and the Office of Engineers of the War Department. The work has been aided also by such State and national organizations of sportsmen and conservationists as the American Wild Fowlers, the American Game Protective Association, and the Izaak Walton League of America.

The work of cooperators has been stimulated, systematized, and checked up through field contacts by the leaders, and the reports received, totaling many thousands, furnish the basis for a far more detailed and comprehensive knowledge of the status of waterfowl in North America than has heretofore been available. The information has been carded and indexed for ready reference, and preliminary maps prepared showing in a graphic way conditions that must be given consideration in formulating plans to insure the maintenance of waterfowl in satisfactory numbers. The results of this survey will become increasingly valuable as they accumulate over a period of years. The undertaking has crystallized and put into effect the feeling of leaders in game-conservation work throughout the country that practical broad-gauge efforts must be made to obtain the facts as a basis for effective administration.

STATUS OF THE WOODCOCK

Inquiry was made and reports were received from more than 300 selected observers among ornithologists and sportsmen regarding the status of the woodcock throughout its present range. The information thus obtained was tabulated and compared with that already on hand in considering the many proposals received regarding measures essential to the adequate protection of this interesting and valuable game bird and in amending regulations governing the open season.

The migratory-bird treaty-act advisory board has recommended that the Bureau of Biological Survey carry out a detailed investigation of the woodcock throughout its range. Much essential information concerning this bird is lacking. A closer check on the migratory flight lines by extensive field study and banding operations is desirable.

ELK IN WYOMING

In accordance with plans developed in the preceding year, in cooperation with the State game and fish commission of Wyoming, the Forest Service, and the Bureau of Animal Industry, an experienced biologist has been engaged throughout the year in a study of the Jackson Hole elk. This is in harmony with recommendations made by the commission appointed by the President's committee on outdoor recreation. Detailed and comprehensive information is being obtained regarding the number, the breeding and feeding habits, and the seasonal movements of these elk, as well as their range and food requirements in relation to livestock grazing, and their diseases and parasites or other causes of depletion. The Bureau of Plant Industry and the United States National Museum have aided by identifying important forage plants consumed by the elk. Study of the grazing habits of the elk is being made in accordance with methods used by the Forest Service in studying the grazing habits of livestock, in order that the results may be useful in working out plans helpful to the local game and livestock interests, as well as to those of other regions where similar studies are needed. The seasonal movements of the elk and such influencing factors as food, temperature, shelter, and insects are being studied. Observation is being made on the influence of predatory animals, including cougars, wolves, and coyotes, on the decrease of the elk. Statistics are not now available on the number of elk killed by hunters, but the State fish and game commission of Wyoming has arranged to obtain reports on this subject in connection with the issuance of future licenses. No cases of starvation were observed during the past winter, during which conditions were rather favorable, and it is believed that there were few, if any. All animals examined had full stomachs, and in few cases was the food improperly digested.

Elk parasites collected, and later identified by the Bureau of Animal Industry, included tapeworms and cysts, lung worms, grubs, and ticks. One adult bull elk and two adult cows were found affected by scab, and several others were reported. Particular attention was given to diseases throughout the winter and spring. A total of 409 animals were found dead, and 193 postmortem examinations were made. Of this number 70 showed definite evidence of necrotic stomatitis, and others presented indications of this disease. The diagnoses are based largely on the reports made by the Bureau of Animal Industry on diseased tissue submitted. These studies involved about 7,000 animals, so the total loss was approximately 5.8 per cent. There was a total of about 1,406 calves with a known loss of 259, or approximately 18 per cent. The presence of squirrel-tail in the hay and undue concentration of the herds on feeding grounds are apparently largely responsible for the prevalence of necrotic stomatitis. If these causes can be eliminated or reduced the herd will be safer from ravages of epizootic diseases. It seems impracticable to treat diseased elk, hence preventive measures are required.

The ideal arrangement would be to maintain the elk in as nearly a wild state as possible. Effort should be made in the direction of preserving the elks' natural instincts, so that they will care for themselves properly and obtain their own food as far as possible. The feeding of hay in severe winters will doubtless continue to be necessary, but the feed should be free from disease-inducing plants.

ELK IN ARIZONA

At the request of the Forest Service and of State officials in Arizona, a representative was detailed to the Chiricahua Mountains to investigate and report on the practicability of introducing elk into that region. His study was made in cooperation with

representatives of the Forest Service, the State game department, the State game protective association, and the local stockmen's association. Consideration of all the factors involved appeared adverse to the proposal, but it was recommended that effort be made to increase such other desirable game species as mule deer and wild turkey.

DEER IN PENNSYLVANIA

In response to an urgent call from the board of game commissioners of Pennsylvania a biologist was detailed to examine conditions attending the large loss of deer in certain parts of that State. His studies revealed conclusive evidence of overstocking, overgrazing, and consequent starvation of thousands of young deer. Copies of the report were furnished to the State board of game commissioners, the Forest Service, and the game departments of other States where similar conditions might obtain, and it was also republished extensively in periodicals devoted to game interests. The report included information regarding the history of game management in Pennsylvania, the present abundance of deer, their food habits and food supplies, damage by deer, and the losses that had occurred, with suggestions for improving game-management practices. Many letters received indicate that similar losses occur in other sections, and this analysis of conditions in Pennsylvania is thus proving helpful in other States.

BROWN BEARS IN ALASKA

Some concern has been felt relative to the status of the Alaskan brown bear, but investigations conducted by the survey in the spring of 1928 indicate that there has not been such a serious decrease in the numbers of this unique American animal as to warrant fear of its extermination.

STUDIES OF OTHER BIG GAME

A number of other special studies were carried on during the year, including investigations in cooperation with the Office of National Parks of Canada and the American Wild Fowlers concerning destructive agencies and other factors that affect the numbers of waterfowl on their breeding grounds.

A report on the caribou of Alaska, based on studies carried on during the past several years, was prepared for publication.

COOPERATIVE STUDIES OF WILD LIFE IN FORESTS AND PARKS

MAMMALS AND BIRDS IN SOUTHERN FORESTS

In cooperation with the Forest Service a preliminary study was made during the months of April and May at the forest experiment station on the Bent Creek area of the Pisgah National Forest in North Carolina to determine the numbers, activities, and habits in relation to forest production of the mammals and birds inhabiting the area. Four areas of 2 acres each in three distinct forest types were selected for trapping operations. These were visited daily to remove specimens and record observations.

Studies also were made of injury by rodents or other animals to seedlings and young growth of valuable forest trees. Lists of birds and mammals found on the experimental areas and in the vicinity were kept, and observations made regarding their numbers and general feeding habits that might be a factor in the success of forest production. The stomachs of all rodents collected were preserved for laboratory study.

PORCUPINES IN RELATION TO FOREST PRODUCTION

Studies of the porcupine have demonstrated that this animal is seriously important economically, and that where it is locally abundant control operations may be needed. In the Southwest porcupines occur commonly in places on the Tusayan, Coconino, Carson, and San Juan National Forests. Although characteristically forest animals, they may be found at considerable distances from trees, and are partial to ridges, gullies, rocky breaks, caves, and bowlder slopes. In this region they prefer the bark of moderate-sized yellow pines to that of other trees, but injure also other pines, firs, spruces, and junipers.

In certain parts of the Southwest porcupine damage is probably second only to that caused by fire and mistletoe. In larger trees the damage is chiefly to the tops, the upper portions of the trunk being so peeled and girdled that the summit of the tree is either killed or deformed. Porcupines also consume a considerable quantity of foliage, thus retarding the growth of trees. The fact that porcupines often revisit particular trees in the course of their wanderings through the woods has afforded a vulnerable

point of attack in planning control work.

CONTEMPLATED STUDIES OF FOREST ANIMALS

Forest wild-life research will be conducted on an increasing scale in accordance with provisions of the recently enacted McNary-McSweeney bill, which provides for the gradual, effective development of a forest-research program. Among other lines of research it authorizes participation by the Biological Survey in experiments and investigations in determining the life histories and habits of forest mammals, birds, and other forms of wild life, whether injurious to forest growth or of value as a supplemental resource, and in developing the best and most effective methods for their management and control. This is a most far-sighted and important piece of legislation and will make possible the systematic organization of research and the assembling of basic information essential for national, State, and local programs for the development of forests and forest resources.

ANIMAL LIFE IN GRAND CANYON NATIONAL PARK

Near the close of the fiscal year conferences were held and plans arranged for cooperation with the Carnegie Institution of Washington, the National Academy of Sciences, the National Research Council, and the National Park Service in efforts to learn what correlations there are of the present animal and plant life with that of the geological formations in various national parks. This investigational and educational program, beginning in the Grand Canyon of Arizona, should afford important and interesting information regarding features to be observed by visitors to the parks.

INVESTIGATIONS IN GEOGRAPHIC DISTRIBUTION

BIRD MIGRATION

Many records have been added to the geographic distribution files of the Bureau of Biological Survey during the year from data gathered by correspondents and cooperators, and from general literature, about 40,000 additions having been made to this valuable file of approximately 1,500,000 records. Maps of the breeding ranges of many species have been revised. Progress has been made in the preparation of a bulletin on the distribution and migration of North American swallows. Revision of a circular on the spread of the European starling in North America to 1928 was completed and forwarded for publication at the end of the year, supplementing the information published in 1925. Technical Bulletin No. 26, Our Migrant Shorebirds in Southern South America, which sets forth the dangers that beset many of the northern species in their winter homes, was issued during the year. Another outstanding report, Technical Bulletin No. 61, Wild Birds Introduced or Transplanted in North America, prepared by John C. Phillips, a collaborator of the bureau, details the meager success that has attended the numerous efforts to introduce foreign birds and transplant native species. Bird-migration records have been brought to date and include reports received during the year from the 200 cooperative observers.

BIRD BANDING

The banding of birds continues to yield increasingly interesting and valuable information. The opportunities afforded by this method for intimate acquaintance with the birds and for obtaining definite information regarding their habits, migratory movements, and distribution, make a strong appeal to bird students. The number of qualified cooperators has continued to grow steadily until a point has been reached where existing facilities for this investigation are inadequate to meet the demands upon the bureau. A great accumulation of data emphasizes the necessity for the publication of reports that are demanded by educational institutions, cooperators, and bird students generally. At the close of the year more than 1,400 persons, including 99 in Canada, were on the list of bird-banding cooperators. The methods employed and the results obtained have aroused much interest in European countries, and a comprehensive account of trapping methods for "ringing" birds, as banding is termed in England, was prepared in the Biological Survey and published in November in British Birds Magazine.

During the year 195,000 bands were purchased for the use of cooperators, and the number of birds already reported as banded during the year totals 127,105, an increase of more than 35,000 over the previous year, bringing the total banded since 1920 to more than 400,000. Return records reported during the year total approximately

7,000. Technical Bulletin No. 32, Returns from Banded Birds, 1923 to 1926, including tabulations of the more than 10,000 sets of return data received, was published during the year, and a popular explanation of the purposes and accomplishments in bird banding appeared in the 1927 Yearbook. An extended popular article, Bird Banding, the Telltale of Migratory Flight, published in the National Geographic Magazine in January, elicited much favorable comment.

Outstanding during the year was the banding of 5,000 mallard ducks at the National Bison Range, Moiese, Mont., returns from which show that birds from that section winter chiefly on the Pacific coast, from Washington south to southern California. This is one of the many instances where significant information has been obtained regarding the movements of waterfowl. The percentage of returns to the total number of waterfowl banded should afford a basis for calculating the approximate numbers of these birds when reliable information is obtained regarding the annual kill by hunters. A manuscript on this phase of the work has been prepared for publication under the title "A Method of Determining the Annual Fluctuation in the Abundance of Waterfowl."

Progress has been made in the preparation of a manual showing the most satisfactory methods of trapping and handling birds for banding. Bird banding is stimulating its devotees to record the results of their work, and is thus yielding information of importance, as indicated by a list of more than 500 articles on the subject, recently compiled in the bureau.

CENSUSES OF NONGAME BIRDS

The censuses of birds other than waterfowl have been continued as in previous years and provide valuable data regarding the breeding of birds on selected areas throughout the country. The reports of cooperative observers provide specific information regarding the relative abundance of species, and the observations accumulating over several years yield data for a better understanding of the abundance and breeding habits of this class of birds.

BIOLOGICAL SURVEYS OF MAJOR AREAS

Further progress has been made during the year toward the completion of a biological survey of Wisconsin. A report on the mammals and life zones of Oregon was practically completed, one on the birds of Washington was finished, and one on the birds of Florida is well under way. An extensive report on the birds of New Mexico was in press at the close of the year, being published by the State game commission of New Mexico in cooperation with the State game-protective association and the Biological Survey. Comprehensive reports finished during previous years, but still awaiting publication, include annotated lists of the birds of Texas and of the mammals of New Mexico.

IDENTIFICATION AND TAXONOMIC WORK

Conclusions in research on any of the biological sciences have little, if any, scientific worth unless the identification of the species involved is accurate. The work of identifying specimens is particularly vital in studies along economic or medical lines, since wrong determinations may result in losses of property or even of human life. The direct bearing of taxonomic work on all phases of the operations of the bureau and of cooperating Federal and State agencies and education institutions makes desirable a considerable enlargement of this phase of the survey's work. The scientific collections of the bureau now include approximately 63,000 birds and 135,000 mammals. Not only are these collections the basis of important research work of the staff, but they are also available for the use of special workers in other institutions. During the year a revision of the North American lemming mice was published in the series of the North American Fauna (No. 50), and at the end of the year a review of the American long-tailed shrews (North American Fauna No. 51) was in press.

LIFE HABITS OF INJURIOUS AND BENEFICIAL SPECIES

Mammals, especially certain rodents, may often become serious pests, and, on the other hand, many mammals are mainly beneficial in their effect on the soil and in their control of various fungi, rusts, or insects that might otherwise do extensive damage. Recent studies of the life habits of mammals have been concerned chiefly with jack rabbits, ground squirrels, prairie dogs, kangaroo rats, and porcupines.

RODENTS AND RANGE FORAGE IN ARIZONA

Biological investigations in the Southwest have dealt primarily with

the relations between native rodents and range forage, conducted in cooperation with the Forest Service, the University of Arizona, and the Carnegie Institution of Washington. Quantitative determinations of the food of rodents have served to emphasize the importance of these relations. The work has demonstrated that the native animal population of the Southwest is a fundamental factor in range management.

Intensive studies have been conducted to determine the effect of native rodents on plant growth, particularly forage. These included the results of overgrazing by native rodents, a habit that prevents satisfactory reproduction of some of the more valuable plants, thus causing them to be crowded out by others less desirable. Several experimental plots are maintained in Arizona, and on these the experiments have proved that palatability of plants obtains with rodents as well as with livestock, and that prairie dogs and cattle have essentially the same order of preference for the more palatable and nutritious grasses. Analyses of data obtained on the experimental plots over a 10-year period have shown that prairie dogs often reduce production of the more valuable forage grasses from 25 to 80 per cent. In some instances they have been known to destroy some of the more valuable grasses over extensive areas.

There is an intimate relation between the number of rodents and the available forage, the rodents tending to multiply in direct proportion to the increase in food. It is thus clear that if stockmen wish to reap the benefits from the increased forage that comes with improved range management they must control the rodents.

JACK-RABBIT DEPREDATIONS

Investigation of the life history and habits of jack rabbits has shown that these are among the most important of the rodent pests over considerable areas in the Southwest and West. Stomach contents examined show that their principal food there is mesquite, chiefly leaves, although pods are frequently eaten. The grass destroyed, which is next in importance, can not be shown by calculations based entirely upon the quantity of food eaten, as much is cut down and left lying on the ground.

Feeding experiments with the black-tailed jack rabbit in Arizona showed that on the average 18 rabbits eat 1 ton of dry forage in the course of a year. Weights of the antelope jack rabbit average about 9 pounds; of the adult black-tailed jack rabbit about 5½ pounds. These animals have been found highly adaptable as to food and feeding conditions. At dry periods they consume much cactus, but as soon as other vegetation appears they leave this for more palatable plants. They consume the same foods that livestock eat, but are likely to be more destructive to both grasses and browse since they graze more closely.

Investigations of the breeding habits of both the antelope and the black-tailed jack rabbits have shown that the breeding period extends over at least nine months, from December to September, during which time several litters may be produced. In extremely arid sections rabbits are likely to be very scarce, while on slopes at the bases of the mountains where the grasses are best they are more abundant.

ANIMAL PESTS OF BULBS

In the Pacific Coast States studies of the habits of rodents, moles, and certain birds in relation to the growing of bulbs and bulbous plants were continued. These were designed to provide information to meet the needs of American bulb growers in a region where an important new industry is in the making, the soil and climate being favorable for bulb production to supply the winter trade of florists. Certain types of plantings have been found particularly susceptible to rodent injury, and some to attack by introduced game birds.

Throughout Oregon and California the pocket gopher is the chief offender, by reason of its general distribution and its persistent habit of storing food. In the more northern coast sections, meadow mice primarily, and moles as accessories, constitute serious pests. Experiments were conducted to determine means to protect bulb plantings by controlling the animals.

BEAVER TRANSPLANTING

Studies were continued of the habits of beavers, and work was done in improving methods of taking these animals alive in localities where they are troublesome. Experiments were continued also in establishing them in situations where they are desired to conserve water and promote fish production, to provide a source of profit from their pelts, or to furnish objects of

interest and attraction, as in parks. Technical Bulletin No. 21, Beaver Habits and Experiments in Beaver Culture, bringing to date the details of this project, was issued during the year.

HARBOR SEALS IN COASTAL WATERS

Some work on the feeding and other habits of the harbor seal served to call attention to the urgent need of establishing definitely the economic status of this species and of the larger sea lion, through study of their relations to the fishing industry. The Bureau of Fisheries of the Department of Commerce expressed a desire that the survey obtain information on the subject as a basis for determining policies of State and Federal Governments with reference to these animals in waters along the Pacific coast, including Alaska.

TULAREMIA AND ITS SPREAD BY WILD ANIMALS

In response to requests made at the national game conference of the American Game Protective Association, at which tularemia in wild animals was discussed by bureau representatives, a mimeographed circular was issued to summarize pertinent information regarding this epizootic disease as it relates to game animals and birds, with information as to practical ways by which hunters or others handling carcasses of infected animals might safeguard themselves. Quarantine measures were recommended to prevent the introduction of diseased animals for restocking. Copies of the circular were sent to game commissions, sportsmen's and conservation periodicals, and the public press, and served to bring to the attention of the public generally the importance of exercising care particularly in handling wild rabbits to avoid infection with this debilitating or even fatal disease. The active interest of sportsmen, conservationists, and game officials was enlisted in preventing introduction of the disease among the native stock through the liberation of the game animals affected. One shipment of wild rabbits, sick and dying from tularemia, was detected and promptly destroyed by game officials in Massachusetts, one of the few States in which the disease has not been found among native animals or human beings.

Progress has been made in investigations inaugurated by the Bureau of Biological Survey in cooperation with the United States Public Health Service to determine the possible susceptibility of ruffed grouse and other game birds to tularemia. The blue grouse was found susceptible to the disease following laboratory inoculation with virulent material from diseased animals at the spotted-fever laboratory of the Public Health Service at Hamilton, Mont., and similar results were obtained with the ruffed grouse in cooperative investigations at the University of Minnesota. Studies are being continued to determine whether these and other important game birds may be infected by rabbit ticks or other natural carriers, and whether the disease may be prevalent among them in a wild state.

ALASKA REINDEER INVESTIGATIONS

The chief problems in reindeer investigations are concerned with breeding and feeding; the reaction of the reindeer and caribou to handling; reproduction, carrying capacity, and the worth of Alaska forage plants in grazing use; and the development of a satisfactory plan for range management. Investigations are conducted at the bureau's reindeer experiment station at Fairbanks, Alaska, and on typical grazing areas elsewhere in the Territory. Assistance also is given to reindeer owners at their round-ups in demonstrating improved methods of counting, marking, and ownership distribution of animals.

A member of the station staff was detailed to Washington during the winter and visited various points in the United States where grazing investigations were in progress, in order to note improved methods and equipment adapted to Alaskan conditions.

Through the courtesy of an Alaska reindeer corporation, several reindeer carcasses were furnished for use in studies in the department laboratories in Washington to determine the most satisfactory market cuts, the chemical and nutritive properties of the meat, and improved methods of dressing, handling, storing, and cooking. These investigations were conducted in cooperation with the Bureaus of Agricultural Economics, Animal Industry, and Home Economics of this department, and in consultation with the Alaska division of the Bureau of Education of the Department of the Interior, which supervises reindeer production and use among the natives of Alaska.

REINDEER EXPERIMENT STATION

Early in the winter the Alaska Railroad Co. constructed a substantial house on the railroad right of way on the campus of the Alaska Agricultural College at Fairbanks and furnished it as residence quarters for the reindeer experiment station staff. Transfer to these quarters was made on January 1. Through the cooperation of the Alaska Agricultural College, office space also was provided in the main building of the college. This provision of quarters and office space for the experiment-station staff has greatly facilitated progress in investigational work.

Fencing was completed on two pasture areas of 32 and 325 acres, respectively, at the station, and three transfer corrals and one shelter shed were erected. In addition fences have been started on four additional pastures of 390, 58, 72, and 20 acres. This equipment at the station has been provided with a view to handling about 75 reindeer and caribou for experimental investigations and for inclosing a small herd of buffalo from the national bison range, Montana, to be kept under observation there. The total station area under fence at the present is 397 acres; that in process of completion is 520 acres; leaving about 260 acres to be fenced the coming year. Additional lands have also been made available by Executive order for use in the station work.

REINDEER FORAGE STUDIES

Quadrat studies of forage were continued during the year, and additional inclosures were established both in the interior and on the Bering Sea coast. These are designed to provide definite information regarding vegetative succession and climaxes, as well as plant reproduction and reaction under grazing use, and should afford a basis for conclusions regarding carrying capacity and range management.

Three initial carrying-capacity projects on lichen range were completed during the winter. These, supplemented by lichen-feeding tests in the feed lot, indicate a winter requirement per animal of 20 to 30 acres, based on the average range, and that probably a 30-year recovery period will be necessary. Further study on an extended scale is necessary for a more definite determination of both forage value and recovery period.

Under the most favorable conditions in feed lot or in pasture during light snow cover, where the food was easily accesible the reindeer and caribou held their own on the lichen diet or made minor gains. Under severe conditions, however, with the snow cover about 2 feet in depth, where the animals were forced to rustle extensively for their food they lost in weight, the average loss per animal over an 84-day period being 17 pounds. These tests have demonstrated clearly that the lichen forage is not a fattening food but merely a convenient maintenance forage for winter use. The lichen requirement per head per day is 20 to 30 pounds, air-dry weight, for animals averaging about 175 pounds.

FEEDING EXPERIMENTS

Feeding studies have been continued to determine the cultivated foodstuffs that reindeer and caribou will eat and the quantities required. This is in preparation for further study as to the economic possibilities of winter feeding in connection with local farming operations and as to the effect of such feeding on meat production. It has been demonstrated that reindeer will thrive on cultivated foods and may be fattened as are other classes of livestock. The effect of feeding balanced rations is now being observed. It has been shown by the tests conducted at the station that the use of baled hay is not economical, since about 50 per cent of it is wasted. The use of prepared foods, such as alfalfa meal and molasses meal, is 50 to 60 per cent cheaper, since all the food is eaten and the freight cost is less. Records maintained indicate an annual requirement per head of 3 pounds of salt on ground feed or pasture, and 5 pounds on such dry feed as hay and grain.

CROSSBREEDING WITH CARIBOU

Crossbreeding of reindeer with caribou, including reciprocal crossing, has been successfully initiated. Six fawns from such crosses were born last spring at the station. Their average birth weight was 14½ pounds, a distinct net gain of about 5 pounds over that of the reindeer fawns, which average only 9½ pounds. Weighing showed that on an average these fawns double their weight in 15 days. Observations on the results of the caribou crossbreeding experiments made on Nunivak Island during the year also indicate gain in size as a result of the cross. The gestation period is 240 days. Normally does shed their horns

five to seven days after dropping the fawn, and variations in this respect indicate some abnormal condition. It is believed that the crossbreeding with caribou will prove of benefit not only in increased size but also in greater hardiness, spirit, and rustling ability. The caribou doe proves to be a better mother and better rustler than the reindeer.

REINDEER PARASITES AND THEIR CONTROL

Important information on the life history of the warble and nose flies affecting reindeer was obtained at the reindeer experiment station through the collection and rearing of grubs. This indicates that June 20 is about the most important date for control work, as it is the time of the last dropping of grubs and the first hatching of eggs. Information now available indicates that moving the herd at this time from the range where the fawns are born and where the last dropping of grubs occurs, to a summer pasture 15 to 20 miles away, will greatly reduce infestation.

Heavy infestation of reindeer by nose grubs greatly reduces their vitality and is at times fatal. The nose fly has been found to be an even greater menace to reindeer than the warble fly. The latter nevertheless is exceedingly troublesome, causing irritation and loss of condition, and the deposition of larvae of blowflies in the open wounds caused by warbles frequently results in the death of the animals.

INVESTIGATIONS IN ECONOMIC ORNITHOLOGY

LABORATORY INVESTIGATIONS OF THE FOOD OF BIRDS

Examination has been completed of all English sparrow stomachs on hand, a total of more than 8,000. This brings to a close laboratory work that has been in progress intermittently for nearly 10 years and makes available for study a mass of material far greater than has ever before been used in determining the economic status of a single species of bird. It is more than three times as great as the starling material used as a basis for Department Bulletin 868, and this was more than the combined material of all European investigators of this bird, including Collinge, Newstead, and Gilmour. This furnishes an idea of the relative scope of the English sparrow examination and that of studies of the food habits of other birds. The indexing and tabulation of the items from the 8,000 stomach cards remain to be completed before the information will be in form available for publication. This is in itself a slow and tedious piece of work that will take months to complete.

During the year 1,555 stomachs and 61 pellets of birds were examined in the laboratory. The majority of these were from birds of prey, supplemented by the stomachs of English sparrows mentioned above, and of shore birds, bobwhites, crows, and other species. The birds of prey were of 32 species, and their examination marks an important step toward the preparation of a new bulletin on this economically important group. Among this material were several lots submitted by individuals and institutions interested in the status of these birds, including game officials of the State of Washington and of the Royal Ontario Museum of Zoology at Toronto, Canada. Examinations also were made of stomach material collected during the cooperative study of quail in Georgia.

FOOD OF OTHER VERTEBRATES

There were examined also the stomachs of 263 mammals of 18 species from six States and Alaska. Among them were stomachs of prairie dogs, deer, elk, seals, and a number of predatory animals. Examination of reptile and amphibian material included 109 stomachs of alligators, snakes of several kinds, and bullfrogs. In addition to the laboratory examinations of stomachs, work on the economic study of reptiles has been advanced by the issuance of a revised edition of a mimeographed circular on poisonous snakes. A popular article in the 1927 Yearbook discussed briefly the food habits and economic status of toads.

REPORTS ON INVESTIGATIONS

Manuscript for a farmers' bulletin on the European starling has been brought to date and at the close of the year was in the process of publication. There was published a technical bulletin (No. 24) on The Magpie in Relation to Agriculture, which dealt not only with the economic status of the bird, based on a study of its food habits, but also included suggestions for control measures where necessary. This bulletin responds to a long-felt need among ranchers, poultry raisers, and bird students in the West, where the magpie plays a rôle comparable

with that of the crow in the East. Farmers' Bulletin 755, Common Birds of Southeastern United States in Relation to Agriculture, was revised. The economic status of several of our birds that at times are in need of control was briefly treated in a mimeographed circular, issued for the use of field men of the bureau, and setting forth logical policies for the curtailment of damage, with a view to uniformity in handling matters of this kind throughout the country.

On the basis of field work in 1925 and 1926 and subsequent laboratory examination of about 1,300 stomachs, a manuscript has been prepared for a technical bulletin on the relation of blackbirds to the rice crop in the Gulf coast area. An article on Blackbird Control in Grain Areas in the 1926 Yearbook was also based largely on this investigation.

LOCAL STUDIES OF INJURIOUS AND BENEFICIAL BIRDS

CROWS IN ILLINOIS

For a number of years crows in southern Illinois have been inflicting severe damage on the corn crop raised on bottom lands adjacent to the Wabash and Ohio Rivers. Appeals have been made for aid in lessening these annual losses, and campaigns of wholesale destruction urged. Although reduction in the number of crows usually can be most economically effected during the winter months, when food scarcity tends to force these birds to take baits and enter traps, a study indicated that winter conditions in southern Illinois were not well suited for such operations. Light snowfall, little frost, and an abundance of food in abandoned or incompletely harvested fields of corn all conspire to make crow control there extremely difficult. So adverse were conditions that attempts to trap for banding even limited numbers of crows to determine individual migratory movements proved unprofitable.

BIRD ENEMIES OF CELERY PESTS

Study of the relation of birds to the leaf tyer and other insect pests of celery was continued in Florida in the spring of 1928. With the insects appearing in reduced, and thus more nearly normal, numbers than during the previous spring, the observations on the habits of birds were considered particularly valuable. Though less conspicuous work was done by palm warblers and tree swallows than during the previous year, when there was a great abundance of the insect, these birds, together with bobolinks and red-winged blackbirds, were rendering excellent service in destroying celery pests. This is especially noteworthy, since in the South the two birds last named are themselves frequently regarded as pests where rice crops are ripening and being harvested.

BIRD ENEMIES OF CHESTNUT WEEVILS

In the first year (1926) of the project of increasing bird foes of chestnut weevils, carried on in cooperation with the Bureau of Plant Industry in the experimental chestnut orchard at Bell, Md., a total of 17 broods of birds was produced in the approximately 50 bird houses erected on a tract of 2½ acres. In 1927, with the same equipment, the number of broods rose to 40. In the spring of 1928 the nest boxes were doubled in number, and the experimental area correspondingly increased in size. The results attained up to the 1st of July with this added equipment gave indication of a still greater response on the part of the birds, one that can be fully appraised, however, only at the close of the nesting season.

WILD-FOWL DISEASE AND FOOD INVESTIGATIONS

DUCK MALADY IN THE WEST

Attempt was made during the summer of 1927 to diagnose the cause of duck mortality in southern Oregon, where on several occasions large numbers of ducks have perished under circumstances that indicated a cause other than alkali poisoning. The outbreak of the duck malady was too limited to permit a full investigation, but enough was learned to show that although alkali was present, it may not have been the sole cause. Evidence pointed to a possible combination of agencies, some of which may not have been present at Great Salt Lake, Utah, where, a few years ago, alkali was found to be the source of the trouble.

FOOD RESOURCES OF WILD FOWL

The survey of the wild-fowl food resources of the upper Mississippi River wild life and fish refuge has been completed as far south as Prairie du Chien, Wis. The past year's work included the surveying and reporting on fully 250 lakes and sloughs and the summarizing of data on some of the major areas of the refuge. Progress was

made also upon the survey of the very numerous lakes and marshes of the State of Minnesota, a project that will probably be completed in another season's field work. Reports on the work in former years in Montana, North Dakota, and Missouri still await publication.

Special investigations of the wild-fowl food resources were made in two localities in South Carolina, two in North Carolina, and one each in Georgia, Virginia, Michigan, and Ontario. The Virginia-North Carolina inspection related to Back Bay and Currituck Sound, localities over which sportsmen have been much concerned because of damage there by salt water to the food plants of wild fowl. The supply of wild-duck foods was found better than in other recent years, but consisted almost entirely of a single species, sago pondweed, which has considerable resistance to salt. Apparently the improved conditions noted are due mainly to heavy rainfall during the growing season, and the menace to Back Bay and Currituck Sound as winter homes for wild fowl will probably continue so long as there is a flow of salt water into them.

STUDIES OF OTHER GAME BIRDS

COOPERATIVE QUAIL INVESTIGATION

Excellent progress was made in all phases of the quail study being conducted in southern Georgia in cooperation with a committee of sportsmen interested in the betterment of quail conditions. A large part of the investigational work was concluded by March, 1928, though plans have been made to continue certain experiments and studies during part or all of the following fiscal year, at the conclusion of which it is planned to publish a final report. Analyses of the stomach contents of nearly 400 additional quail gave further insight into the food preferences of these birds, and this will assist in making recommendations for the propagation of suitable food-producing plants.

During the summer of 1927 every effort was made to perfect the "adoption system" of artificial quail propagation that has been used on a productive scale by five privately financed ventures in the vicinity of the field headquarters of this study. Eggs are obtained and incubated by the usual methods, but as soon as the chicks are hatched they are taken from the bantams and given in batches of a dozen to 15 to cock quail that have previously been captured afield. The chicks are promptly adopted and cared for perfectly, and when a week old are released with their foster fathers. This system is proving to be an easily workable one under conditions prevailing on southern quail preserves.

Nesting studies of the quail were concluded late in the summer of 1927, bringing the total of nests studied up to 602. Results of this phase of the project have been already analyzed and will be detailed in the manuscript of the final report.

Considerable time was devoted to the study of the parasites of quail, especially intestinal parasites. Through a cooperative arrangement with the Bureau of Animal Industry a specialist was detailed for a period of approximately two months to the headquarters of the investigation at Beachton, Ga., where she studied the life histories of nematodes and cestodes prevalent in quail. One of the field assistants of the investigation spent some time also on the Virginia State game farm to observe the diseases and parasites of the young birds.

As the investigation is nearing its close, the banding of quail has been largely discontinued. Approximately 100 returns of banded quail were reported during the year as a result of shooting or trapping, and additional information obtained as to the movement of both the native and the introduced Mexican quail.

PROPAGATION OF GAME BIRDS

Two game farms were inspected during the year, and a preliminary manuscript revision was made of the Farmers' Bulletin on Propagation of Game Birds. It is planned to issue the new publication in two parts, one devoted to the upland game birds and the other to the aquatic. Findings from last year's study of methods used in game-bird rearing establishments in Europe have been incorporated in the new reports, and three other manuscripts on species suitable for introduction, on duck ponds, and on systems of game management, based in part on information obtained during the European investigations, have been prepared for outside publication.

INTRODUCTION OF GAME BIRDS

In addition to the bulletin issued to summarize information on wild birds introduced or transplanted in North America, a manuscript was prepared on game birds suitable for introduction into the United States. These reports cover both historical and current theoretical and practical aspects of a problem that is of great interest, particularly to sportsmen.

INVESTIGATIONS OF FUR RESOURCES

CONSERVATION OF FUR ANIMALS

Various constructive conservation programs are serving to maintain many fur animals in the wild. State and other programs have accomplished a great deal, but much remains yet to be done. In performing its part in this work the Bureau of Biological Survey has sent specialists to attend a number of meetings in various parts of the country of societies interested in fur animals and other wild life, and these have made special effort to put before the public the need of well-systematized fur-protective activities. The characteristics of various fur animals, their relative abundance, and their distribution have been brought to the attention of the fur trade by a series of monthly articles in the official organ of the National Association of the Fur Industry. Information of an educational nature has been distributed in cooperation with this association in the form of a booklet for school use that describes the life habits and utility of various animals for fur. Lantern-slide lectures and radio talks also were given. In the introduction to Farmers' Bulletin No. 1552, Fur Laws for the Season 1927–28, it is pointed out that our natural fur resources are steadily diminishing.

FUR-FARMING INVESTIGATIONS

Along with the nation-wide effort to conserve wild life, the raising of wild animals in captivity has continued to grow. It has been evident during the past year even more than previously that fur farming is rapidly developing into a stable, sound, and businesslike industry. Not all fur animals are suitable for raising in pens, but attempts have been made with most of them. A leaflet entitled "Recommendations to Beginners in Fur Farming," first issued in mimeographed form, has been prepared for general distribution.

FUR-FARMING IN ALASKA

Under an agreement between the Governor of Alaska and the department, work among the fur farmers of Alaska is being conducted by a veterinarian selected by the Biological Survey with a view to the betterment of conditions. The veterinarian inspects as many fur farms as possible, maintains contact with fur-farming projects under extremely varied conditions, and furnishes specialized information to the ranchers. His efforts are particularly directed toward more efficient methods of feeding, control of diseases and parasites through sanitation and treatment, and improving housing conditions.

DISEASES OF FUR ANIMALS

The concentration of large numbers of foxes and other fur animals on small areas has given the infectious diseases to which these animals are subject the opportunity to assume epizootic proportions, and heavy losses on some farms have been encountered. In an effort to be of the greatest assistance to fox ranchers in controlling these outbreaks it was necessary to study the causative organisms, the progress of the diseases, and protective measures. A 5-year cooperative agreement was entered into with the University of Minnesota, where considerable work on this project had been already in progress. The facilities provided at the medical school of the university have enabled the workers to observe epizootics on several ranches in that part of the country from the time of their onset to their termination. Several hundred foxes were given detailed post-mortem examinations, and laboratory studies were made of practically all the organs of the body, together with the pathogenic organisms obtained.

Two distinct infectious diseases of high virulence are recognized in foxes, and preliminary tests indicate the possibility of immunizing the animals. A preliminary nontechnical presentation of the parasitic and other diseases of foxes, including the so-called distemper, appeared in the 1927 Yearbook of the department. Further tests on a large scale are in progress.

FUR ANIMAL EXPERIMENT STATION

At Saratoga Springs, N. Y., the Bureau of Biological Survey maintains its fur animal experiment station, where extensive experiments on methods and practices in raising vari-

ous fur animals in captivity have been conducted. Before the establishment of the rabbit experiment station at Fontana, Calif., studies had been begun at the fur animal experiment station to determine the relative rate of growth of young rabbits of different breeds on various rations. Weights were recorded at intervals of a few days to learn the ages at which the most rapid growth was made and the most profitable development reached. Differences in climate, food, and other factors in the two sections will afford considerable comparative data for use in making recommendations on the management and care of rabbits.

Studies have been continued of the various factors influencing the quality of pelts of foxes, including comparisons of rations and changes in management. The influence of diet on breeding animals was studied, and certain significant facts were developed that may explain the frequent failure of foxes to reproduce. A mimeographed leaflet entitled "Feeding Vixens and Pups," made available for distribution during the year, describes the feeding methods recommended.

Crosses of various strains of foxes were made with the view to determine means of avoiding objectionable features in the offspring and the possibility of fixing desirable qualities. This project was somewhat handicapped by lack of animals of the necessary quality. It is desirable that several foxes having the desired characteristics be obtained to supplement the stock now on hand.

The silver fox is the principal species being raised in captivity for its fur alone. During this year the importations of foxes from Canada showed a decided decrease. On the other hand, a number of large exportations of silver foxes as well as other animals were made to various European countries. For the information of an increasing number of interested persons, a leaflet (No. 8) entitled "Mink Raising," was published during the year, and a mimeographed leaflet, Raising Raccoons, also was issued. The raccoon, marten, skunk, and muskrat seem tolerant of captivity, but it is questionable whether the muskrat and some of the others can be profitably raised under pen conditions. A growing interest in the raising of muskrats on natural marsh areas is resulting in frequent calls for advice regarding their food plants, the type of marsh land best adapted for their use, and habits, enemies, and diseases. Mimeographed leaflets on the care of ferrets and on the care of white mice and rats were revised and reissued to supplement correspondence.

Karakul sheep are being raised in different parts of the country, and investigations indicate that they will become a valuable addition to the group of animals raised under fenced conditions for their pelts.

Rabbits are among the most numerous of fur animals now being raised in captivity, the distribution of the industry including every State. They are raised for a twofold purpose, as they can be utilized both for food and for fur.

Parasitic diseases, which in some degree are common to practically all fox ranches, have been given special attention. Since almost every animal must be treated a number of times during its life for worms, fleas, or mites, it is important that the simplest and most efficient methods be determined. Lungworms appear to be increasingly numerous and widespread in this country, and a satisfactory treatment for them has not been developed. Attempts at mechanical removal of these worms from the trachea have been made, in most cases successfully, and the animals were partially relieved. This method, however, is far from ideal, and further investigations are planned.

Studies have been made of the breeding habits of martens in captivity, and five additional animals have been purchased for experimental work. A progress report on the marten-breeding experiments of the survey was prepared in the bureau and published in November in the Journal of Heredity. A leaflet (No. 6), briefly stating the history and location of the experiment station and its chief accomplishments, was published early in the year, under the title "Experimental Fur Farm of the Biological Survey."

RABBIT EXPERIMENT STATION

The recent extensive development of the rabbit industry in this country led to a cooperative project at the close of the preceding fiscal year between the department, the National Rabbit Federation, and a local corporation interested in raising rabbits, for the maintenance of a rabbit experiment station at Fontana, Calif. The station consists of 5 acres of land, on which is a residence, an administrative building with offices and laboratory, rabbit buildings, hutches, and

other equipment. It was furnished and stocked with rabbits at the expense of these cooperators of the department. The station is now being operated by the Bureau of Biological Survey, and attempts are being made there, as well as at the fur-animal experiment station in New York, to ascertain the most economical and practical methods of feeding, housing, and raising the various utility breeds of rabbits. Leaflet No. 15, Rabbit-House Construction, and No. 22, Chinchilla Rabbits for Food and Fur, were published to facilitate the distribution of information called for along these lines.

RESEARCH IN ERADICATION METHODS

Predatory animals, such as coyotes, wolves, mountain lions, and bobcats, have been the cause of millions of dollars loss every year to livestock in the so-called range States ever since the time of the early settlers. Beneficial forms of wild life also have suffered by the depredation of these animals. Enormous losses also have been inflicted on agricultural crops by such injurious rodents as prairie dogs, ground squirrels, jack rabbits, field mice, pocket gophers, and rats—not only in the western agricultural regions, but in the East also, where many of these rodents, such as field mice, woodchucks, and rats, have given the farmer much concern and still cause great loss.

ERADICATION METHODS LABORATORY

Investigational work for the development of improved and economical methods in control operations against these destructive animals was conducted throughout the year at the eradication methods laboratory maintained by the bureau at Denver, Colo. Much information was gained on the efficiency of the various poisons employed, and control methods were improved. Particular attention was given to the use of thallium sulphate as a poison, and to the various compounds of strychnine, both in sulphate and alkaloid form. Reports on the characteristics and use of red squill and thallium sulphate in the control of injurious rodents were completed for publication as technical bulletins.

LEADERSHIP IN WILD-LIFE CONTROL

During the last week of April a conference of leaders in rodent and predatory-animal control was held at Ogden, Utah, the first meeting of the kind since 1919. Of outstanding importance among the accomplishments was the development of detailed policies to be followed in the conduct of control operations, including preliminary research work. When fully operative, this will effect considerable economies of time and funds, and even before the close of the year it had permitted an extension of control work without increased financial resources.

Other definite recommendations made at the conference will mean considerable improvement in the laboratory and field methods. Realignment of the present personnel in keeping with these recommendations will permit the employment of an administrative officer for the laboratory, an experienced pharmacologist, and five field investigators. The extension thus made possible in the personnel of the eradication-methods project will centralize investigational work in control methods, thus giving district leaders more time for actual control operations.

At the conference of field leaders the policy to be followed was definitely stated to be one of control of injurious wild life rather than of eradication. The fact remains that the bureau must work for the eradication of certain species locally where their destructiveness is so impressive that no other policy of handling them is permissible. For example, the gray wolf and the prairie dog are so deleterious to agriculture and stock raising that their presence in some localities can not be tolerated. Other species, such as the coyote and the ground squirrel are so prolific and occur over such wide areas that their extermination, even if desired, would be impossible. The Bureau of Biological Survey is not embarked upon a general extermination program, and the main objective is so to control the predatory animals and rodent pests as to reduce economic losses to a minimum.

COOPERATIVE CONTROL OPERATIONS

The importance of controlling injurious wild-mammal pests can not be overemphasized. The Bureau of Biological Survey has been constantly called upon for additional assistance in control operations, but the resources at its disposal have not permitted an extension of cooperative work. No request for assistance received during the year, however, has failed to receive attention—the individual was given assistance either through correspondence or by actual field demonstration. It

is becoming more noticeable each year, however, that if control measures as developed by the Bureau of Biological Survey are to be effective, it is imperative to get into close touch with all possible cooperators and to furnish them with expert assistance. Increased personnel throughout the country is desirable to meet the demands for leadership of this kind. Trained leadership in field operations has been a great factor in the development of efficient hunters, trappers, and poison operators.

COOPERATIVE FUNDS AVAILABLE

Federal and cooperative funds available during the year permitted organized field work on the control of predatory animals and injurious rodents in 18 States. Federal funds totaled $477,880, of which $22,718 was used in research work at the eradication methods laboratory; $278,939 in control of predatory animals; and $176,223 in the control of rodents and other small animal pests. Cooperative funds from 14 of these States aggregated $347,556, and in addition, cooperating counties, livestock associations, and individuals within the respective States raised $679,065, making a total of $1,026,621 in cooperative funds, of which $432,359 was expended for the control of predatory animals, and $594,262 for rodent control. Approximately $1,481,773 was used in control operations under the leadership of the Bureau of Biological Survey, of which $455,162 was from the Federal Treasury. Table 1 gives a summary of cooperative funds used during the year.

PREDATORY-ANIMAL CONTROL

Greatly extended operations are essential in the range States, if the problems in predatory-animal control are to be solved. That the stock interests in these States look to the Federal Government for more adequate and equalized expenditure is evident from the annual resolutions of State livestock associations as well as correspondence received from hundreds of private stockmen. The Federal Government should provide more adequate financial support whenever practicable, particularly since there still exists in large numbers on the Federal domain a heavy infestation of predatory animals, which eventually invade private and State lands and are taking a $20,000,000 annual toll from the producers of livestock and poultry.

WOLVES AND COYOTES

At the request of the Governor of Alaska, following an appropriation of $10,000 for the purpose of cooperation with the Bureau of Biological Survey in predatory-animal control, one of the bureau's experts was detailed to the Territory to make a study of the best method of attacking the predatory-animal situation there. Wolves and coyotes in Alaska are committing serious depredations on deer, mountain sheep, fur bearers, and on many of the game birds, including ducks and ptarmigans.

TABLE. 1.—*Cooperative funds made available for use in campaigns against wild animal pests in cooperation with the Bureau of Biological Survey*

States	Rodent work			Predatory-animal work			Total rodent and predatory-animal work		
	State	Other sources	Total	State	Other sources	Total	State	Other sources	Total
Arizona	$14,999	$67,758	$82,757	$14,998	$1,163	$16,161	$29,997	$68,921	$98,918
California		259,890	259,890	19,966	46,970	66,936	19,966	306,860	326,826
Colorado	605	12,874	13,479	497	22,734	23,231	1,102	35,608	36,710
Idaho	4,436	22,951	27,387		17,434	17,434	4,436	40,385	44,821
Kansas	12,901		12,901				12,901		12,901
Montana		25,914	25,914	25,476	4,774	30,250	25,476	30,688	56,164
Nevada	1,499		1,499	16,980		16,980	18,479		18,479
New Mexico	27,548	15,279	42,827	35,406		35,406	62,954	15,279	78,233
Oregon	10,476	5,535	16,011	19,074	19,944	39,018	29,550	25,479	55,029
South Dakota		1,242	1,242	15,195		15,195	15,195	1,242	16,437
Texas	6,134	37,002	43,136	24,782	50,543	75,325	30,916	87,545	118,461
Utah	5,045		5,045	30,355		30,355	35,400		35,400
Washington	2,879	31,431	34,310	36,148	2,199	38,347	39,027	33,630	72,657
Wyoming	5,268	18,866	24,134	16,889	10,832	27,721	22,157	29,698	51,855
Eastern United States		3,730	3,730					3,730	3,730
Total	91,790	502,472	594,262	255,766	176,593	432,359	347,556	679,065	1,026,621

Predatory-animal control operations were carried on in all the States from Montana to Texas and westward, and also in South Dakota. Organized cooperative work was inaugurated before the close of the year in Oklahoma and Arkansas, States in which wolves as well as coyotes are causing severe depredations on wild game, domestic stock, and poultry. Coyote control was carried on to a limited extent also in southwestern Kansas and on the Niobrara Federal game reservation in Nebraska. In illustration of the success of the work it may be cited that in western Colorado one woolgrower, who lost 60 lambs and 8 ewes during lambing operations a year ago, states that on account of control work of Biological Survey hunters on this particular range, during the past year he lost only 1 lamb. He stated also that he had enjoyed the added advantage of being able to let his ewes and lambs run loose without molestation.

In Coos County, Oreg., the county agent reports an increase in sheep of more than 300 per cent, due entirely to the control of coyotes by poisoning methods conducted by the survey. Likewise, in Josephine County, Oreg., the county agent cites a substantial increase in the turkey business since the inauguration of coyote campaigns there. Forty-eight stockmen in 16 counties in Utah report greatly reduced coyote depredations on their ranges as a result of the work of survey hunters. In one Texas county a Biological Survey hunter killed a female wolf that within a year's time had destroyed $5,000 worth of registered sheep and goats. In another county two wolves responsible for a $2,000 loss in livestock in 12 months, as well as a female coyote that had caused a loss of $1,200 by similar depredations, were killed.

The coyote is probably the most aggressive of the predatory species and continues to present the major predatory-animal problem on western cattle and sheep ranges. It can maintain itself in the face of advancing civilization and through the persistent warfare conducted against it by inexperienced individuals, it is becoming wary of man's traps. As a result, control is extremely difficult in certain sections of the West. The coyote is a prolific breeder, and often an area in which complete control has been attained may become reinfested in a very short time. During the past year more complaint than heretofore has been received from cattlemen of losses of young calves by the coyote, one ranchman near Greenland, Colo., reporting the destruction of 100 young calves through its depredations. Such ground-nesting birds as grouse, ducks, and quail also are its constant victims. The control of this predator in areas of heavy infestation is possible only by coordinated action of Federal, State, and private agencies.

The gray wolf is under control in all States west of the one-hundredth meridian. The small red wolf of eastern Texas, however, is still the cause of severe depredations on livestock, but marked progress toward its control has been made during the year.

The total number of coyotes destroyed during the year, for which skins or scalps were actually obtained, was 35,709; gray wolves, 11; and red wolves, 716. In addition, it is estimated that 48,000 coyotes were destroyed by the use of poisons but not recovered.

MOUNTAIN LIONS

Biological Survey hunters disposed of 219 mountain lions during the year—18 in Utah, 17 in Oregon, 23 in Montana, 38 in New Mexico, 108 in Arizona, and 15 in other States. In Arizona the figure given brings the grand total of mountain lions killed in the State in 12 years to 910.

BEARS

In the course of the year it became necessary to kill 226 bears known to prey on livestock. Bears in general are not predatory in their habits and are usually classed as game. Individuals, however, that become predatory must be destroyed. The policy of the Biological Survey regarding the bear is to establish definitely that an individual has become addicted to stock-killing before it is considered predatory. The policy was detailed in a popular article, Bears Sometimes Unjustly Blamed as Stock Killers, prepared in the bureau and published in the 1927 Yearbook.

In Alaska the large brown and grizzly bears are classed as game animals and may be taken legitimately only during open seasons. The black bear is classed as a fur animal and may be taken in the open trapping season throughout the Territory except in the northern part of fur district No. 2, where, because of local depredations, it may be taken at any time. There has been, and still is, some complaint regarding the menace of the Alaska

brown bear and the grizzly to life and property. The regulations under the Alaska game law concerning the taking of these animals provide that "any person may kill a large brown or grizzly bear at any time when such animal is about to attack or molest persons or property, or when found within half a mile of a residence or human habitation."

It is felt that this regulation gives wide latitude to those who may encounter dangerous or destructive individuals of the species in question. In general, the testimony from reliable sources throughout Alaska is to the effect that the large brown and grizzly bears, with but few exceptions, avoid mankind as much as possible and that mauling or actual killing of human beings by unmolested bears rarely occurs.

BOBCATS AND CANADA LYNXES

Bobcats and lynxes are the source of considerable loss to livestock, especially to sheep during the lambing season, but are readily brought under control by trained hunters. During the year 4,838 bobcats and 40 lynxes were taken in the States in which predatory-animal control was undertaken by the bureau.

CONTROL OF RODENTS AND OTHER SMALL MAMMALS

Organized rodent-control operations were carried on during the year under the leadership of the Biological Survey in 18 States, and educational work in 10 others. The operations benefited several Eastern States, including North Carolina, which was this year added to the list.

In the field operations 3,306,000 pounds of poisoned bait, 141,580 pounds of calcium cyanide, and 626,463 pounds of carbon disulphide were used in controlling rodent pests on 14,545,591 acres of land. Besides other poisons, more than 88,000 ounces of strychnine were used in preparing bait, of which 74,000 ounces were purchased through the bureau from the manufacturers at a saving to cooperators of approximately $37,000. The saving under this plan allowed the cooperative funds available to be used in more extensive operations.

Control work was carried on in cooperation with such other agencies as agricultural colleges, State departments of agriculture, county agricultural agents and other county officials, and farmers' and stockmen's associations; and with the Extension Service and the Forest Service of this department; the Office of Indian Affairs and the Bureau of Reclamation, of the Interior Department; and with individual farmers and stockmen. The cooperation received from these agencies, including work, materials, and money, is very gratifying, the funds being more than three times the amount expended by the bureau from Federal appropriations.

The importance of the results may be judged from replies to a questionnaire mailed to 4,018 cooperators in one State. These estimated that as a result of the year's work in rodent control in that State alone there was a saving in crops, range grasses, and fruit trees of $474,235.

Rodents are of numerous species and they are so widely distributed that uncontrolled their damage to farm crops and forage would be appalling. A comprehensive rodent-control program, more drastic than present funds permit, is called for. Much has been accomplished, but very much remains to be done.

GROUND SQUIRRELS

Ground squirrels of various species are generally distributed over the area west of the Mississippi River, and in Wisconsin, Illinois, Michigan, and Indiana. Their destructiveness to agriculture consists mainly in damage to growing grain, forage crops, and garden vegetables. Practically every crop grown on the farms in the infested areas is subject to damage by them. In irrigated sections they also burrow through the embankments of canals and dams and cause their destruction and the ruin of crops on adjacent agricultural lands. Much loss is sustained also in their consumption of forage on the open ranges. According to signed statements made by 4,037 farmers in one Western State alone, during the years 1918, 1919, and 1920, there would have been a total annual loss from ground squirrels of $2,087,742 in farm crops on 638,971 acres, or an average of $3.26 an acre, practically all of which was prevented by the cooperative work with the survey. Estimates obtained this year from farmers in various localities of Montana, where the infestation averages five or more ground squirrels to the acre, indicate that each ground squirrel can destroy during a season 75 cents worth of grain, or at the rate of $3.75 an acre.

The Biological Survey carried on campaigns to control the depredations of ground squirrels in all States west of the Great Plains, and in Kansas and South Dakota. Excellent financial and other cooperation was received, and in most cases losses in agricultural crops were kept at a minimum. In this work 2,690,479 pounds of poisoned bait, together with 119,868 pounds of calcium cyanide and 610,580 pounds of carbon disulphide, were used on a total of 11,104,749 acres. Of these quantities 103,715 pounds of poisoned bait were furnished by the bureau and used on 862,731 acres of Federal land, most of which was on national forests and other public domain.

The destruction of ground squirrels on public domain adjacent to private holdings is of great importance in many localities in the West. These Federal lands are a center of infestation, and if the pests are not controlled there, permanent relief is impossible on adjacent property. The bureau is handicapped in its work on Federal lands by lack of sufficient funds, and only a comparatively small acreage now infested can be treated.

One of the real accomplishments in cooperative ground-squirrel control during the year was the establishment of a central bait-mixing station in the Idaho district, similar to smaller stations that have been in operation in other districts. Such a station assures a district good poisoned bait uniformly mixed, and makes available at all times adequate quantities at the lowest possible cost. Savings made possible by the central plant come from the use of machinery and low-priced labor on such routine work as mixing, sacking, and distributing, thus affording field leaders, county agents, and other cooperators more time for field work. The saving to the bureau and to the extension service in Idaho in time and reduced cost of materials amounted to more than $3,000 for the season, in addition to savings effected for other cooperators. Between March 15 and June 30 more than 175,000 pounds of mixed bait were handled, and 75 per cent of it was delivered by truck direct to cooperators at various points in the State.

PRAIRIE DOGS

Prairie dogs of several species are distributed over the Plains States and westward to the foothills of the Rocky Mountains, as well as in Utah, New Mexico, Colorado, and Arizona. They cause serious loss in farm crops, but probably inflict the greatest damage on range forage. In control operations 463,049 pounds of poisoned bait, 2,960 pounds of calcium cyanide, and 5,000 pounds of carbon disulphide were used on a total of 2,484,011 acres in Arizona, Colorado, Kansas, Montana, New Mexico, South Dakota, Texas, Utah, and Wyoming. In this work 96,314 pounds of poisoned bait were used on 673,360 acres of Federal land. In several of these States extensive areas have been cleared of prairie dogs, resulting in a material saving to the livestock and farming industries. One stockman of Arizona reported that "poisoning prairie dogs on my range saved me about $2,000 worth of grass." Another reported, "I estimate we saved over $5,000 by clearing prairie dogs from 4,200 acres." Conditions regarding the treatment of Federal lands in the control of ground squirrels apply also in the case of prairie dogs.

JACK RABBITS

Jack rabbits inhabit practically all of the territory west of the Mississippi River and are responsible for considerable loss in farm crops, particularly in alfalfa and grain, and also in range grasses and fruit. In the Southwest they do considerable damage to cotton plants. During the winter they destroy hay in the stack, and in summer consume a large quantity of forage on the range. The heaviest damage occurs during periods of extended drought. That rabbits destroyed 40 tons of hay in the stack on one farm during a winter season is shown by court records in Lincoln County, Idaho. Midland County, Tex., alone records a loss of $95,000 this year from reduced cotton yield from their depredations. In orchards the rabbits girdle the trees and eat the bark in winter, when other food is scarce.

Operations for the control of jack rabbits, conducted in 13 States during the year, resulted in the protection of large crop areas. An example of this protection is furnished in a report from one cooperator in Arizona as follows: "I estimate that you saved $30,000 worth of cotton for us in this district by assisting us in poisoning jack rabbits." Many other reports of similar nature have been received.

A continuance of efforts begun last year by field men of the bureau to market wild-rabbit skins gave added impetus to the cooperative control of jack rabbits. During this year more

than $160,000 was received in this way by cooperators in Colorado, Idaho, Kansas, Montana, South Dakota, Utah, and Wyoming. If a profitable market for these skins is maintained, the problem of controlling jack rabbits will to a large extent be simplified.

POCKET GOPHERS

Pocket gophers of various species are distributed over much of the United States and become a serious farm and orchard pest in many localities. They not only eat growing grain but cover much more of it with soil. Their burrows and mounds prevent close mowing and interfere with and break machinery, and their burrows in irrigation ditches result in deep gullies on sloping land, waste of water, and interference with its distribution. They cause costly breaks in dams and embankments of irrigation canals. An orange grove in Arizona was sold at a loss of $10,000 because of damage by pocket gophers to the tree roots. The owner of another grove had his net annual income cut $2,500 when he lost 250 trees from pocket-gopher work. A break in an irrigation canal near Gila Bend, Ariz., caused by pocket gophers, resulted in a $35,000 crop loss and required nearly $5,000 for repairs.

Cooperative campaigns for the control of pocket gophers carried on in 15 States afforded protection to large areas of forage and grain crops and fruit and forest trees, as well as to irrigation water. It is well to give typical examples of the protection afforded: An irrigation-district superintendent at Tuscon, Ariz., reported, "We have poisoned pocket gophers on our irrigation project the past four years under the management of your assistant and have had splendid results. I would estimate the saving at at least $4,000." A date grower reports an estimated saving of $10,000 worth of date palms through pocket-gopher control work. A farmer says: "Saving from pocket-gopher poisoning on 540 acres estimated at $1,200." On the Nebraska National Forest 14,000 acres of pine plantations were treated in cooperation with the Forest Service, and the damage by pocket gophers was checked, whereas in the past 25 years about a third of all trees planted had been killed by the rodents.

A two-reel motion-picture film, Million-Dollar Pockets, graphically depicting methods of coping with pocket gophers, was released during the year and has been shown in practically every State in which the bureau is conducting control operations. The film has stimulated great interest and has accomplished much in bringing before the public the necessity of destroying pocket gophers in localities where they are actively or potentially injurious.

FIELD AND HOUSE MICE

In addition to house mice, several forms of field mice are distributed over the whole of the United States, the degree of infestation varying to a great extent from year to year. During some years these rodents are scarce in certain localities in which in other years they increase to large numbers and inflict heavy damage to farm and orchard crops, in some cases ruining entire fields. The injury to field crops is brought about by mice eating the roots of the plants reached by their numerous burrows. The injury to fruit trees and shrubs consists in the destruction of the bark near the surface of the ground. When the girdling is complete and the cambium eaten through, the action of the sun and wind soon complete the destruction.

There are many cases in which 20 per cent or more of the trees in orchards are killed by mice. One orchard in Washington State suffered 50 per cent damage this season, and a heavy infestation of mice in Jones and Lyman Counties, S. Dak., was responsible for the loss of more than 40,000 acres of corn. Damage by house mice to grain in storage in warehouses of the northern Sacramento Valley, Calif., has been reported as amounting to $100,000 for the year. The pine mouse, a species of field mouse, is exceedingly destructive to fruit trees and shrubs in the Eastern States and to a minor extent to bulbs and root crops also.

Field-mouse infestations of serious proportions were noted in California, Idaho, Oregon, South Dakota, Washington, Utah, and many Eastern States. Control was undertaken in the West in these States and in the East in North Carolina, Maryland, Maine, Pennsylvania, and Vermont. More than 53,000 pounds of poisoned bait were used in the Wenatchee and Yakima districts in Washington alone to control this pest.

BROWN RATS

The brown rat, introduced from the Old World and now established in ev-

ery State of the Union and the Territory of Alaska, is the most injurious of rodents. Feeding indiscriminately, it damages manufactured and other commodities and destroys all kinds of vegetable and animal matter, and at the same time contaminates large quantities of food. As a disease carrier the rat is a serious menace, and is responsible for deaths among human beings through its spread of bubonic plague and other infectious diseases.

An example of rat depredation that indicates the extent of its destructiveness and shows something of the range of agricultural products concerned was furnished during the year in Galveston County, Tex. One fruit grower reported that rats ravished his berry patch to such an extent that instead of his being able to ship 115 lugs (boxes) of berries as he had the previous year, he could pick only 4 lugs this season. One farmer reported a loss of $500 in sweet potatoes and turnips from 20 acres, and another reported a loss of $60 in figs, $1,500 in trees girdled, and $100 in truck crops. Losses in watermelons, cantaloupes, tomatoes, carrots, beets, beans, and corn were also reported in the same county, one farmer stating that he lost $1,000 in watermelons on 10 acres through depredations of rats.

Action in the control of rats has been undertaken during the year in 16 States in the form of organized antirat campaigns in cities and country districts or demonstrations showing methods of destroying this pest. Among the cities in which extensive antirat campaigns were conducted were Portland, Oreg.; Tacoma, Wash.; Oakland City, Ind.; Stevens Point, Wis.; and Sylva, N. C.

Notable among the campaigns in country districts was one in Texas organized in 54 counties. In the course of the work 22,200 pounds of barium carbonate were used in preparing poison baits, and prizes were offered to persons destroying the most rats. As a result 3,690,528 dead rats were counted in these contests. On the basis of the estimate of governmental and industrial experts that each rat will destroy from $1.80 to $2 worth of foodstuffs and other property in a year, this represents an immediate total saving of more than $6,500,000 to Texas, the amount of property these rats would have destroyed if they had lived another year. In the campaign in Ellis County, Tex., with a population of less than 57,000 persons, 243,321 rats were destroyed in one month, probably a world's record.

Farmers' Bulletin No. 1533, Rat Control, issued at the beginning of the year, has been in great demand, and about 200,000 copies have already been distributed. A motion-picture film, How to Get Rid of Rats, also was released during the year and has been shown in practically every district of the United States where rats are injurious.

WOODCHUCKS

Woodchucks inhabit rocky places, woodlands, and bramble thickets, and from the nature of their habitat, come in contact with agriculture only in scattered localities. When their haunts are immediately adjacent to farm lands, however, they become a serious pest. In the East they appear to be more numerous in certain agricultural areas than formerly, and in many open fields are now burrowing far from their usual haunts. Woodchuck damage is diverse and affects many different crops and fruit trees, and particularly such forage crops as alfalfa, clover, and other legumes. In control measures undertaken in eight States poisoned baits and calcium cyanide as a fumigant were used. A leaflet (No. 21) entitled "Woodchuck Control in the Eastern States" was issued and has been widely distributed.

PORCUPINES

In the forested areas of the West the increase in numbers of porcupines is very evident, and much damage is done to trees. It is important that control measures be taken in many of the national forests to protect both the well-developed trees and the younger growth. Control operations were carried on in six States, the accomplishments in Oregon and Arizona being especially noteworthy, and considerable progress in methods of preparing poisoned baits was made during the year. A leaflet on porcupine control, based on field and laboratory research, is in preparation.

OTHER INJURIOUS RODENTS

Other injurious rodents, including the wood rat and the kangaroo rat, are responsible for considerable loss to agriculture in certain sections of the country. Where these rodents are numerous enough to be injurious, control measures have been recommended.

MOLES

Moles are found only in the Pacific coast region and in the eastern half of the United States. Where they burrow in such places as gardens, lawns, and fields, they are considered a pest because of the displacing of plants, covering of growing crops, the use of their runways by field mice, and the obstruction their mounds offer to the use of machinery. The damage caused by moles in bulb-raising areas in the Northwest is coming to be of considerable economic importance because of the rapid increase in this industry.

CONTROL OF ANIMAL-BORNE DISEASES

RABIES

Sporadic cases of rabies were reported and verified during the year in Oregon, being possibly the remnant of a heavy outbreak that occurred in that State in 1926. In Nevada, 14 positive cases were recorded, 3 in coyotes, 2 in bobcats, 5 in domestic cows, 2 in sheep, and 1 each in a domestic dog and a house cat. These cases indicate that rabies is still fairly well distributed over that State. Biological Survey hunters in Nevada took rabid animals from five counties, where some livestock was lost, but the spread of rabies was expeditiously suppressed in practically all cases. In Colorado during early spring a rabies outbreak of considerable proportions occurred in the area between the towns of Golden and Boulder, the disease being confined entirely to dogs, and so far as known not reaching predatory animals. Sporadic cases of rabies occurred in Washington, particularly in the eastern part of the State, but through effective cooperation of the Washington State Department of Health and the State college at Pullman it has been possible to detail hunters quickly to districts where outbreaks threatened and to utilize this expert personnel to reduce the number of predatory animals by the use of both traps and poison.

TULAREMIA

Tularemia among jack rabbits in South Dakota and among field mice in California was reported during the year, and measures of control were undertaken by the rodent-control force of the bureau.

BUBONIC PLAGUE

Two cases of bubonic plague among human beings have been reported in Contra Costa and Santa Cruz Counties, Calif., one of which proved fatal. Positive cases of the plague were found in ground squirrels from these counties as well as in those from Alameda, San Benito, Monterey, and San Luis Obispo Counties. Special attention is being given in cooperation with State and Federal public health officials to checking the spread of the disease in the infested areas through reducing the ground-squirrel population.

MAINTENANCE OF WILD-LIFE RESERVATIONS

As civilization advances, the removal of forests and the drainage of marsh and water areas for cultivation and industrial purposes continues, and the necessity for establishing more reservations for migratory birds and big game throughout the United States increases proportionately. The refuge idea as a means of conserving valuable wild life is not new. It has already been well tested and successfully used in several States as a means of restocking depleted covers, and the steady increase of birds and animals on the Federal reservations during the year is further proof of the soundness of the system. It is now recognized that the refuge system or some extension of the principle is the only means by which the extermination of many of the valuable forms of wild life can be prevented in North America.

To be most effective, a game or bird reservation must be given constant attention by a resident protector, one who is thoroughly familiar with the area. Frequent patrols are necessary to prevent poaching and to control predatory animals or other natural enemies. The upkeep and increase of food plants and the checking of disease also are important functions of reservation protectors and require continuous attention and study.

Reservation administration falls within three recognized lines of activity: (1) The acquisition of lands for reservations; (2) the protection and maintenance of bird refuges and game preserves, and their wild life; and (3) restocking with suitable species. Land acquisition is now going forward on the upper Mississippi River wild life and fish refuge and the newly authorized Bear River migratory-bird refuge and requires the services of engineers, surveyors, and land valuation and purchase experts. Included in protection and maintenance of reservations is watchfulness for the welfare of the animals, improving the areas for their

use, and facilitating enjoyment by the public.

Reservations make it possible to restore to surrounding or similar areas indigenous forms of wild life that may have become extinct by reason of overshooting or other causes. The utilization of surplus stock on reservations for transporting and planting elsewhere is increasing from year to year.

A list of wild-life reservations under the jurisdiction of the survey and of other branches of the Federal Government was published in the Yearbook for 1927, and recent changes are mentioned in this report. The total number under the jurisdiction of the bureau at the end of the year was 78.

BIG-GAME PRESERVES

Fenced preserves and other areas for big game under Biological Survey jurisdiction are the national bison range in Montana, the Niobrara reservation in Nebraska, the Sullys Hill game preserve in North Dakota, the Wind Cave game preserve in South Dakota, all of which are surrounded by game fence; and the winter elk refuge in Wyoming. No seriously adverse conditions at these reservations were experienced during the year. The approximate number of big-game animals on these reservations on June 30, 1928, is shown in the accompanying table.

NATIONAL BISON RANGE

It has been necessary to reduce the herds of buffalo and elk at the national bison range, Montana, in order to prevent overcrowding and the possibility of disease and starvation through natural increase. This reduction has been effected by the sale or gift of animals for stocking other ranges and for exhibition in public parks and zoological gardens throughout the country, and by slaughter and disposal for food purposes. Twenty-three buffalo from this range were shipped to Alaska near the end of June in an experiment made by the Alaska Game Commission to establish a herd in the Tanana Valley, near Fairbanks, under funds appropriated for the purpose by the legislature of Alaska. The removal of the surplus animals will assist materially in the recovery of forage on the range, although some additional animals will have to be disposed of in order to bring the stock within safe bounds. The building of additional game fences will enable the preserve to carry a greater number of animals by permitting grazing by rotation. The herd of mountain sheep at the bison range has been increased by the birth of 14 lambs, bringing the total number of animals in the herd to 92.

WINTER ELK REFUGE

The winter was one of sufficient severity in western Wyoming to require, as in the previous season, the feeding of a heavy tonnage of hay to an increased number of elk visiting the feeding grounds. The first elk to enter the refuge was a lone bull on November 6; a week later 10 cows and calves came in, and 113 elk were counted on November 20. By the end of November about 2,500 elk were on the refuge and adjacent ranches, and during December and thereafter the number increased steadily. The snow averaged about 1 foot in depth at the end of December, and feeding the elk began on January 12 and continued to April 21. More than 9,000 elk were fed during the winter, a substantial increase over the maximum count of 7,549 the previous year. The total quantity of hay fed by the Federal and State governments was 3,460 tons, compared with 3,006 tons during 1927. The increasing numbers of elk visiting the refuge area emphasize the importance of plac-

TABLE 2.—*Big-game animals on reservations of the Bureau of Biological Survey, June 30, 1928*

Preserves	Buffalo	Elk	Antelope	Mountain sheep	Deer		Total
					White-tailed	Mule	
National bison range, Montana	459	[1] 190	----	92	[1] 34	[1] 150	925
Wind Cave game preserve, South Dakota	189	[1] 155	29	----	----	----	373
Sullys Hill game preserve, North Dakota	17	[1] 29	9	----	1	----	56
Niobrara reservation, Nebraska	90	[1] 106	10	----	1	----	207
Total	755	[1] 480	48	92	[1] 36	[1] 150	1,561

[1] Estimated.

ing a definite limit to the size of the Jackson Hole elk herd, and point to the necessity of providing more winter forage for a suitable number of animals if starvation in another severe season is to be averted.

Early in the fiscal year the Isaak Walton League of America transferred to the department satisfactory title to the 1,760 acres of land in Jackson Hole adjacent to the elk refuge, which the Waltonians had purchased, with a view to increasing the total area in the Government holdings.

The feeding of augumented numbers of elk during the past two winters reduced to a comparatively few tons the stock of hay that had accumulated during previous mild winters. Only about 195 tons remained on hand. The crop on the refuge this year will probably be about 1,500 tons. If next winter should be mild there is a possibility that the refuge hay crop, supplemented by hay purchased by the State of Wyoming, will suffice for the needs of the elk, but another very severe season would result in starvation on a large scale. To maintain and replenish the supply each season, it is important to increase the size of the refuge and thus make unnecessary emergency purchases of hay at high prices. Steps are being taken to increase production on the Government lands and to reduce the proportion of injurious squirrel-tail grass.

In accordance with a recommendation of the elk commission, a biologist familiar with big-game animals was detailed to a study of the life history and needs of the elk. The results of work already accomplished are dealt with under another heading. The elk commission recognized the necessity of acquiring additional land adjacent to the present refuge to insure adequate winter-feeding facilities, and recommended appropriate Federal legislation. A bill introduced in Congress in December to provide for the enlargement of the elk refuge contemplated the acquisition of about 12,000 acres of suitably located land under an appropriation of $275,000. This bill received the approval of the Bureau of the Budget to the extent of authorizing an appropriation of $150,000, with the proviso, however, that this amount would be available only in case an equal amount in subscriptions or land were contributed by the State, counties, organizations, or individuals. The bill still awaits congressional action.

OTHER BIG-GAME PRESERVES

Including three fawns born to the antelope at Niobrara reservation in Nebraska during the year, there are now 10 of these animals at this preserve. The antelope band at Wind Cave preserve, S. Dak., was increased to 29 by the birth of 7 fawns. An 80-inch game fence, which will inclose approximately 4,000 acres of additional rugged land, was brought nearly to completion on the Wind Cave preserve. Five and one-half miles of stock fence also were completed at the elk refuge in June.

UPPER MISSISSIPPI RIVER WILD-LIFE AND FISH REFUGE

Land-acquisition work on the upper Mississippi River wild-life and fish refuge continued. Progress was considerably hampered, however, because of the average price limit of $5 an acre fixed by the legislation that authorized the establishment of the refuge. Many tracts that could not be purchased have been leased with the object of purchase, and this action has assisted in controlling the situation. The present Congress, however,

TABLE 3.—*Young of big game born on reservations of the Bureau of Biological Survey during the calendar year 1927* [1]

Preserves	Buffalo	Elk	Antelope	Mountain sheep	Deer		Total
					White-tailed	Mule	
National bison range, Montana	118	80	-------	20	5	50	273
Wind Cave game preserve, South Dakota	31	14	4	-------	-------	-------	49
Sullys Hill game preserve, North Dakota	5	9	-------	-------	-------	-------	14
Niobrara reservation, Nebraska	11	18	2	-------	-------	-------	31
Total	165	121	6	20	5	50	367

[1] Including some data published in the report covering the fiscal year 1927, the change from fiscal to calendar year being in the interest of greater accuracy in the compilation of figures. Some figures in the text of this report are for the fiscal year.

has authorized the payment of a maximum average price of $10 an acre, and this will facilitate future acquisitions. Joint regulations for the administration of this refuge, as approved June 24, 1927, by the Secretary of Agriculture and the Secretary of Commerce, were issued in July (S. R. A.—B. S. 67), by the Biological Survey, to cover such matters as wild-life protection, fire prevention, and recreational uses of this important area, and have proved adequate.

A resolution recently passed by Congress authorized the acceptance of title to about 488 acres near the city of McGregor, Iowa, donated by James Buell Munn, of New York City, as an addition to the refuge. A large part of this area was not subject to overflow, but will be useful for observation and administrative purposes, and congressional consent was necessary to acceptance. The lands are valued at between $30,000 and $40,000.

OTHER IMPORTANT REFUGES FOR BIRDS

BIG LAKE

Big Lake bird refuge, in northeastern Arkansas, which was deep in water during the flood period of 1927, was visited by an even greater flood this year. The levees around the refuge were threatened, and at one time the water had risen to the treetops on certain areas. Late in June the entire refuge was still under water.

MALHEUR LAKE

At Malheur Lake bird reservation, in eastern Oregon, the water has been higher than for a number of years, with resultant benefit to the waterfowl and growth of their food plants. There appears to be promise that for the first time in four years the young pelicans hatched on the reservation will safely reach maturity.

NEW AND ABANDONED RESERVATIONS

MATANZAS, PATHFINDER, AND UPPER KLAMATH ESTABLISHED

During the year three new reservations were established: Matanzas Bird Refuge, Fla., August 10, 1927; Pathfinder Bird Refuge, Wyo., April 19, 1928; and Upper Klamath Wild-Life Refuge, Oreg., April 3, 1928. The Upper Klamath refuge consists of 5,200 acres of marshland along the west side of the lake of the same name. It is of considerable importance to the waterfowl of the region, in view of the wholesale drainage of marsh areas for agricultural purposes, and especially the practical elimination of Lower Klamath Lake, embracing about 80,000 acres, and formerly one of the most important breeding and resting grounds for migratory waterfowl in western North America.

BEAR RIVER REFUGE AUTHORIZED

The outstanding feature of the year in reservations was the approval on April 3, 1928, of an act of Congress providing for the establishment of the Bear River migratory bird refuge on the marshes at the mouth of Bear River, Utah. The legislation authorized an appropriation of $350,000, of which $200,000 was made available to initiate the work and carry it through the fiscal year 1929.

Through the construction of a system of low dikes, fresh water from Bear River will be impounded over tens of thousands of acres, mainly barren mud flats bordering the present shore of Great Salt Lake. The creation of a refuge in this locality through a system of dikes has several objectives: The spreading of fresh water over the broad salt-impregnated mud flats will end the appalling losses of waterfowl, especially ducks, through so-called alkaline poisoning. It is estimated that in the past few years not less than 7,000,000 ducks have perished from this cause alone within and adjacent to the area to be included in the refuge. It has been found that aquatic vegetation providing an abundance of food for waterfowl grows amazingly in water so impounded, and thus a poisonous death trap for the birds will be converted into a great feeding and resting ground for a host of migrants which in their overland flight, as shown by bird-banding operations, visit points in neighboring States as far west as California. The construction of the dikes will also greatly increase the breeding areas for resident waterfowl and prevent the periodical invasion of salt water due to slight rises in the level of Great Salt Lake. In 1924 an inundation of this sort destroyed thousands of acres of fresh-water marsh in the Bear River Delta, thus contributing very materially to the adverse conditions.

Under the new law not less than 60 per cent of the area is to be maintained as an inviolate sanctuary for migratory birds, the remainder being subject to

possible use as public shooting grounds under regulation. Much of the area involved consists of national domain or of lands that will be added through the cooperation of the State, but some areas must be purchased. Active steps are being taken to initiate the land-acquisition and engineering work.

MOSQUITO INLET REFUGE DISCONTINUED

The Mosquito Inlet bird reservation, near New Smyrna, on the east coast of Florida, became of little value to birds owing to the growth of the town and consequent question of jurisdiction. An Executive order abandoning the refuge was accordingly issued on March 17.

RECREATIONAL USES OF WILD-LIFE RESERVATIONS

Designed primarily to prevent the extermination of numerous valuable and interesting species or to extend to them needed protection, some of the wild-life reservations afford unusual opportunities for recreational enjoyment by the public and for scientific observation and study. Many kinds of wild life are essentially shy and retiring and to thrive must be granted seclusion. This is especially true of bird colonies during the breeding season. The big-game preserves, however, afford places where the public can enjoy the sight of wild animals at short range. Public interest in such recreational advantages is shown by the increasing number of visitors to some of the larger and better-known reservations. This public appreciation is gratifying, although the presence of visitors adds to administrative burdens, and funds are lacking to provide properly for their comfort and safety. The Sullys Hill game preserve, near Devils Lake, N. Dak., continues to attract an increasing number of visitors. During the year 23,233 persons and 4,903 visiting automobiles were recorded, taxing to the utmost the available facilities.

In addition to affording protection to wild life, the upper Mississippi River wild life and fish refuge will ultimately furnish opportunities for public recreational uses at many points. These will include camping, fishing, and even public shooting on certain areas. On parts of the navigable waters and meandered lakes within the upper Mississippi refuge, hunting of waterfowl was permitted during the 1927 season in accordance with State laws and the regulations under the migratory-bird treaty act. Public shooting of migratory game birds is permitted also on a part of the Big Lake bird reservation, Arkansas, and on other refuges where limited hunting will not defeat the purpose for which they were created.

URGENT NEEDS OF RESERVATIONS

Additional funds are required for the proper maintenance of many of the game and bird reservations. During recent years appropriations have permitted the carrying out of only the most vitally necessary improvements and repairs.

ALEUTIAN ISLANDS RESERVATION

The Aleutian Islands bird reservation extends in a chain for about 800 miles southwestward from the end of the Alaska Peninsula. It embraces many large and small islands on which the status of wild life is but imperfectly known. Requests for permits to use some of the islands for sheep raising, fur farming, and other commercial developments require careful consideration to protect the wild life and safeguard the interests of the natives who are dependent upon the island resources for their livelihood. As soon as funds can be made available a regular warden service should be established and a seaworthy vessel provided to patrol the area. A comprehensive survey of the wild life of the reservation and conditions affecting it is needed as a basis for efficient administration.

HAWAIIAN ISLANDS RESERVATION

The Hawaiian Islands bird reservation includes widely scattered islands far out in the Pacific Ocean northwest of Hawaii, constituting as a whole a group of surpassing interest from the wild-life standpoint. Certain of the islands are the natural homes of birds found nowhere else. Some of these birds have become extinct, while others, including the Hawaiian teal, have been so greatly reduced that they are not likely long to survive without special protection. The islands provide breeding places for large colonies of albatrosses and other interesting sea birds, and thus invite raids by poachers and trespass by fishermen. At one time rabbits were unwisely introduced on to some of the islands, and on Laysan, the most important of the group, these rodents so destroyed the vegetation that most of them starved. The destruction of vegetation produced conditions very unfavorable for bird life.

Efforts to eradicate the rabbits with a view to making the vegetation available to the birds have apparently been successful. Two wardens should be placed on Laysan Island and provision made for regular visits to the other islands.

SAVANNAH RIVER BIRD REFUGE

Of particular importance as a haven for certain rare and valuable migratory birds is the Savannah River bird refuge in South Carolina. Thousands of the rare and beautiful wood duck—near extinction a few years ago—nest there. It is made up of abandoned rice plantations and is unusually attractive to all species of wild fowl common to the Atlantic coast, and many woodcock and Wilson snipe visit the area. Unfortunately, funds are not available to provide adequate supervision for this reservation or to mark properly its boundaries.

INVESTIGATIONS OF PROPOSED REFUGES

There is urgent need for funds to enable the survey to investigate and determine the suitability of areas that are being proposed for refuge purposes. During the year an engineer was engaged to make a reconnaissance of the Klamath marsh area in Oregon, to ascertain its suitability for refuge uses. It was found practicable from an engineer's standpoint, but the Indians who control the lands have thus far been averse to making any arrangements with the Government for disposing of them for this purpose. A survey was also made of Lower Klamath Lake to ascertain the possibility of flooding a portion of it so as to restore for migratory waterfowl an area long used by these birds. This was found to be impracticable for the reason that the authorized use of the water for irrigation and other purposes would not leave enough to meet the requirements.

LAW ADMINISTRATION

Respect on the part of sportsmen and the public in general for Federal and State laws for the conservation of wild life continues to increase from year to year, and United States district courts and district attorneys have continued their interest in the enforcement of the regulations. There are still many hunters, however, who will violate the law whenever opportunity is afforded.

PROTECTION OF MIGRATORY BIRDS

BETTER LAW ENFORCEMENT NEEDED

Demands for better enforcement of the Federal migratory-bird regulations are insistent and general. Citizens everywhere express their approval of the law but assert that enforcement is notably inadequate. The reason for this criticism becomes evident when it is realized that the appropriation available for enforcing the migratory-bird treaty act regulations allows for the full-time employment of only 24 salaried game protectors throughout the entire country. Each game protector must on the average cover two States, and in his work can have little assistance from the United States deputy game wardens, since funds are not sufficient to permit many of these latter officials—generally voluntary cooperators—to be assigned to this duty. The fact that United States game protectors are known to be few encourages poachers, market shooters, bird snarers, plume hunters, and other violators to ply their illegal trades in contempt of the law, and serves to bring the Federal regulatory work into disrepute among many sportsmen. The establishment of an adequate force of game protectors would have immediate beneficial results in a quickening of public interest in wild-life protection and in strengthening the public support of the migratory-bird treaty act. It is confidently felt that illegal practices in the taking of migratory birds in the United States can be reduced to a practical minimum by a force of not to exceed 100 protectors.

FEDERAL AND STATE COOPERATION

Cooperation between the game protectors of the Bureau of Biological Survey and the State game wardens has continued with gratifying results and with mutual benefit, for Federal protectors in numerous instances discovered and reported infractions of the State game and fish laws. Information and evidence in connection with such offenses have been referred to the State game departments and have enabled them to collect in fines and costs the sum of $7,860.99. Several United States game protectors have been issued commissions as State game wardens in order to further this cooperation. State wardens also have given Federal officers valuable aid.

Several publications were prepared by the survey and widely distributed to facilitate better cooperation be-

tween Federal and State authorities engaged in conserving our birds and game. One of these was the twenty-eighth annual Directory of Officials and Organizations Concerned with the Protection of Birds and Game, issued as Miscellaneous Publication No. 6 of the department. The annual summary of the game laws of the United States, Mexico, and Canada (Farmers' Bulletin No. 1550) was published, and 390,000 copies were widely distributed; and 110,000 copies of the annual publication containing the fur laws (Farmers' Bulletin No. 1552) were issued. The bureau also issued a pamphlet (S. R. A.—B. S. 68) containing the text of the treaty between the United States and Great Britain for the protection of migratory birds and various Federal laws and regulations for the protection of wild life. The open seasons for game were conveniently set forth in a poster, 16,500 copies of which were issued as soon as possible after adjournment of the State legislatures. This poster was reprinted in numerous sporting and outdoor periodicals, and the information was thus widely disseminated.

A statement compiled by the bureau and issued through the press service showed that about 6,000,000 hunting licenses were issued by the States for the season 1926–27, and that about $8,000,000 revenue was derived from this source. The larger portion of the funds so received by the States is employed in the protection and propagation of game and fish and in the acquisition and administration of lands for State game refuges.

HEARINGS UNDER THE MIGRATORY-BIRD TREATY ACT

No general public hearings or conferences were held relative to migratory-bird conditions, but a part of the annual meeting of the migratory-bird treaty act advisory board, which was held as usual in the city of Washington during the month of December, was open to the public. The board discussed and approved certain modifications in the regulations affecting open seasons on waterfowl in Illinois and affecting the location of sinkboxes (batteries) in coastal waters. Recommendations relative to the open seasons on gallinules and to the open seasons on mourning doves in South Carolina, Georgia, Florida, Alabama, and Mississippi were also approved. These recommendations were adopted by the Secretary and approved by the President. Upon later representation from the State game authorities of Georgia and Louisiana the bureau made further recommendations relating to the open seasons on mourning doves in these States and proposed amendments, which were adopted and approved, to bring the Federal regulations into harmony with State laws.

The status of the woodcock has been given much attention not only by the survey but by the advisory board. In New England and in the Maritime Provinces of Canada reports indicate a gratifying increase of these birds, but in the areas west of the Alleghenies to the Mississippi River and in a major portion of the coastal States a serious decrease has been almost generally reported. The latter areas comprise the larger portion of the woodcock's range, and the unfavorable status of the bird in these regions is significant. Accordingly the advisory board favored the recommendation made by the survey that, notwithstanding the situation in New England, the maximum open season on woodcock be reduced from two months to one month. The regulation effecting this change was adopted by the Secretary and approved by the President.

LAW VIOLATIONS AND PENALTIES

During the year migratory bird treaty act cases were handled and disposed of as shown in Table 4. From lack of sufficient evidence, youthfulness of the accused, the imposition of adequate fines in State courts, or other satisfactory reasons, 83 cases reported by United States game protectors were not forwarded for prosecution. Six cases tried before juries resulted in conviction and the imposition of substantial fines. Penalties included jail sentences imposed by Federal judges in 11 cases, and fines ranging from $1 to $500 and totaling $11,213.05. Defendants were placed on probation in 4 cases and paroled for six months in 1 case, and in 4 cases sentence was suspended. Two defendants were pardoned by the President after having served 30 days of a 40-day sentence. Migratory waterfowl illegally possessed or unlawfully killed valued at approximately $1,000 were seized during the year, and those fit for food were donated to hospitals and other public charitable institutions. Among the violations for which offenders were punished were the following: Selling and shipping waterfowl without Federal permit; trapping ducks; killing ducks in closed season; exceeding the daily bag limit on ducks; shooting waterfowl from power boats; hunting

ducks after sunset and mourning doves prior to half an hour before sunrise; and killing nongame and insectivorous birds for which no open season is provided.

Four persons illegally trapping fur-bearing animals were apprehended by reservation wardens on the upper Mississippi River wild life and fish refuge and prosecuted in State courts, where fines were imposed totaling $90 with $125.25 additional costs; two offenders were remanded to jail for 60 days in default of payment. The first cases involving a violation of the act creating this refuge were reported for prosecution and were pending at the end of the year.

Since the passage of section 84 of the United States Criminal Code, designed to protect wild animals and birds and their eggs on Federal refuges, 79 prosecutions have been instituted in Federal courts. New cases submitted to the solicitor during the past year numbered 4; 5 cases were terminated by convictions, with fines totaling $205; and 1 was dismissed.

PERMITS ISSUED

Scientific collecting and other permits.—Permits issued during the year to collect migratory birds and their nests and eggs for scientific purposes numbered 200, bringing the total outstanding to 1,665. Thirty-seven scientific possession permits were issued during the year, principally to taxidermists, making the total outstanding 321. Permits issued authorizing the possession and sale of waterfowl for propagating purposes numbered 653, bringing the total number of such permits to 3,750; a number of permits of this description were canceled during the year. Outstanding permits for possessing specimens accidentally killed or found dead now number 469, of which 67 were issued during the year.

Reports on file indicate that 42,155 wild ducks, chiefly mallards, and 4,762 wild geese, mostly Canada geese, were raised in captivity under permit. Included in the total were 670 wood ducks and 169 pintails. These figures constitute a noticeable increase over the reports of the previous year. The propagation of game birds is being encouraged in every practical way, and wide use was made of the bulletin on the subject. There is reason to believe that in some areas where ducks, particularly mallards, have become scarce, restocking might be successfully accomplished through the propagation of birds by sportsmen's organizations and by individuals. Many of the wild fowl raised in captivity have been liberated.

Permits to kill injurious birds.—Three orders authorizing permits for the killing of migratory birds when found injurious were issued by the Secretary under article 7 of the migratory-bird treaty and Regulation 10, as follows:

An order (August 10, 1927) permitting the killing of shrikes by leaders of the cooperative quail investigation, or by any reliable person designated by them, in any manner when found injuring or destroying valuable birds on lands in Thomas and Grady Counties, Ga., and Leon and Jefferson Counties, Fla., on which the quail investigation is being conducted.

An order (August 17, 1927) permitting the killing by shooting of gulls and terns throughout the United States by any person when authorized by a permit issued by the Secretary and countersigned by the Chief of the Bureau of Biological Survey, in such numbers as may be necessary, not exceeding 50 in the aggregate of both kinds, and in sections where such birds have become objectionable about private property or a menace to public health. Permits issued under the

TABLE 4.—*Cases of violation of the migratory-bird treaty act handled during the year 1928, disposed of, and still pending*

Cases	Number	Cases	Number
Pending from former year	403	Disposed of by:	
New cases reported	423	Conviction	332
		Dismissal	57
Total	826	Verdict of not guilty	10
		No bill found	3
Disposed of	440	Nolle prosse	20
Pending at end of year	386	Abandonment of prosecution	15
		Denial by court of permission to file information	3
		Total disposed of	440

order are valid for one year from the date of issuance.

An order (May 18, 1928) permitting any person, when authorized by a permit issued by the Secretary and countersigned by the chief official in charge of the fish and game laws of the State of Maine or his duly authorized representative, to shoot herring gulls between July 20 and August 20 of any year for which the permit is issued, when necessary to protect the blueberry crops on areas within the State.

INTERSTATE COMMERCE IN WILD BIRDS AND MAMMALS

Administration of the Lacey Act, which regulates interstate commerce in wild birds and mammals, continues to uncover large numbers of violations of State laws relating to traffic in pelts of fur animals. As heretofore most of the evidence of apparent violations has been referred to State game officials for investigation and State prosecution when the shipments proved to have been illegally made. Federal operations are greatly handicapped, and the illegal traffic continues, from the fact that Federal employees are not empowered to seize illegal shipments of skins and furs. Some headway has been made, however, in restricting violations, in that the courts of one State, to prevent violators from profiting by the sale of furs illegally taken or shipped, have ordered the proceeds of such sales to be paid to the State.

When furs have been removed from the jurisdiction of one State and commingled with articles of interstate commerce in another, usually they are not subject to State seizure. A bill has been introduced in the present Congress to confer authority upon employees of the department engaged in enforcing the provisions of the Lacey Act to seize illegal interstate shipments of the dead bodies of wild animals or parts thereof.

In its cooperation the survey has furnished game-protection officials in the various States with evidence of 4,672 shipments that apparently contained illegal skins. During the fiscal year the several States closed 475 cases based on information originally furnished by the survey, in which the aggregate fines assessed amounted to $17,909.50 and the costs to $1,237.30, a total of $19,146.80. Sixty-five beaver skins were seized at the instance of a Federal protector, and sold by the State for $700. Six cases also were settled in State court by the imposition of jail sentences ranging from 15 to 90 days each.

No cases involving violations of the Lacey Act were reported for prosecution during the year; but approximately 80 investigations were still pending; 258 investigations involving apparent violations were closed.

IMPORTATIONS OF FOREIGN BIRDS AND MAMMALS

The close of the fiscal year marks the completion of 28 years of supervision by the Biological Survey of the importation of foreign birds and mammals. During this period more than 15,000 permits have been issued for the entry of a corresponding number of shipments, including several million birds and mammals. Approximately 9,000,000 birds have been imported during these years, about 6,000,000 of which have been canaries, 2,000,000 miscellaneous birds, and 750,000 game birds. Complete figures are lacking for the first year in which the law was in operation, and also for 1919 and 1920, immediately after the World War, when importations fell off to a small fraction of the former number. With the exception of five years the total number of birds annually imported has varied from 200,000 to more than 600,000, the half-million mark having been passed only in 1927 and 1928. The figures indicated for 1928 have never before been attained. Canaries have averaged 1,000 a day in 1913, 1914, 1927, and 1928, and in four other years (1907, 1910, 1911, and 1912) they almost reached this mark. Nearly two-thirds of all game birds imported have been Mexican quail. Next to these stand pheasants, formerly a large item in the entries, but State game farms and private enterprises now supply most of the stock for this country, and importations have fallen off considerably. Hungarian partridges reached their highest mark, 36,507, in 1911. Miscellaneous birds have normally varied from 40,000 to 200,000, but in late years have fallen below the maximum. Only in 1922, 1923, and 1927 have they exceeded 100,000, but in 1923 they reached 197,265.

The number of permits issued during the year was 1,211, an increase of 144 over that of the preceding year, and inspection of shipments at ports of entry increased from 337 to 411. Six additional permits were issued at Honolulu, Hawaii, for the entry of 53 miscellaneous birds. The total num-

ber of foreign birds imported was 682,308, of which 8,741 were without permit. The importations under permit consisted of 458,449 canaries, 56,307 parrots, 84,915 quail, and 82,637 representatives of miscellaneous species.

MAMMALS

Permits for the importation of mammals included chiefly foxes, muskrats, and bears, and a number of others largely for exhibition purposes. Comparatively few fur-bearing animals except foxes and muskrats were brought in, and so far as known no injurious species were admitted.

The importation of foxes from Canada again showed a decided decrease from the number imported the previous year, 3,044 as compared with 4,242 in 1927. During the past eight years the records indicate that nearly 35,000 have been brought in from Canada, two-thirds of which were entered in the three years 1924, 1925, and 1926, figures for which were 4,781, 8,424, and 7,809, respectively. The peak, reached in 1925, was followed by a slight decrease in 1926, a falling off of nearly 50 per cent in 1927, and a still further decrease during the past year. The fact that the fox-farming industry is steadily progressing and has now reached a more normal and substantial basis would indicate that the increase of 1924–1926 was due to some special stimulation or that the number of fox farms in the United States has now increased sufficiently to supply a large proportion of the breeding stock.

Besides foxes, muskrats for fur farming and black bears for exhibition purposes have been imported in some numbers. A considerable number of the latter species are brought in each year during summer and early fall. Many inquiries have been received regarding the introduction of the South American coypu, with a view to its establishment as a fur-bearing animal, but as yet no actual importations have been made.

Among the most interesting mammals imported during the year were representatives of the two existing forms of sea elephant (Mirounga), the southern form represented by a specimen from South Georgia, imported by a large circus and placed on exhibition during the spring; and the northern by several Guadalupe sea elephants brought in and exhibited by the San Diego Zoological Society. Thus, for the first time, both of these rare mammals were on exhibition at the same time in the United States. Other interesting mammals included four brown hyenas and several rare monkeys.

BIRDS AND THEIR EGGS

The importation of birds included 84,915 Mexican quail, 12,620 Hungarian partridges, several shipments of pheasants, a few waterfowl, and other miscellaneous game birds. For the first time in several years a number of pheasants were brought in from England, chiefly to introduce new blood. Many of the Hungarian partridges were imported by the State of New York and others were shipped to States in the West, where considerable interest in their introduction has developed.

Permits were issued for the entry of 4,956 eggs of game birds, against 530 in 1927. Shipments this year were chiefly pheasants from England, the largest including 1,500 eggs; eggs of ducks and grouse were also entered from Alberta.

Among the more interesting birds imported were a Somali ostrich (*Struthio molybdophanes*), 2 shoebill storks (*Balaeniceps rex*), 2 mikado pheasants (*Calophasis mikado*), 3 Impeyan pheasants (*Lophophorus impeyanus*), and 26 argus pheasants (*Argusianus argus*), 7 Formosa tree partridges (*Arboricola crudigularis*) and 19 chukar partridges (*Alectoris graeca chukar*); a number of rare pigeons, including 5 Caroline Island pigeons, 3 white-fronted amethyst doves (*Phlogoenas kubaryi*), and 2 doves of the species *Claravis pretiosa;* parrots in considerable variety, including several black cockatoos (*Solenoglossus aterrimus*), 4 hyacinthine macaws (*Anodorhynchus hyacinthus*), 5 rare parrakeets (*Psittinus incertus*), and 6 Forster lories (*Trichoglossus forsteri*); 2 queen wydahs (*Diatropura progne*), 3 half-moon wydahs (*Coliostruthus ardens*); and 4 emperor starlings (*Cosmopsarus regius*)—the starlings being imported for the first time in October, 1927.

Mexican quail.—During the season of 1928 the number of quail imported from Mexico was slightly less than in 1927, the total number being 84,915, as compared with 85,141. Of the birds imported this season 28,910 were entered at Brownsville, 33,190 at Laredo, and 22,815 at Eagle Pass, Tex. The system of issuing permits at the border, which proved so successful last year, was continued. The entries, as last year, were made by three import-

ers who held concessions from the Mexican Government. These concessions authorized a larger number of birds than had ever before been imported, and plans were made for shipments on a large scale, but the record of entries shows that the number actually brought in was less than in 1927.

Inspectors of the Bureau of Animal Industry issued all permits for the exact number of birds brought in and examined all shipments at the border before reshipment, but no quail disease was reported. Weekly reports were made on the number of quail entered and details as to shipments. These quail were distributed to about one-third of the States, as follows: Kentucky, 12,155; Alabama, 12,035; North Carolina, 8,719; Maryland, 7,505; Oklahoma, 6,624; Georgia, 5,560; Virginia, 5,496; Kansas, 5,044; Texas, 4,267; Florida, 3,716; Pennsylvania, 3,607; New York, 3,210; Missouri, 1,832; New Jersey, 1,412; South Carolina, 566; and West Virginia, 536. Several small shipments to other States included about 2,585 birds.

New regulations (S. R. A.—B. S. 69), which, among other provisions, modified the size of crates for shipping quail, went into effect on November 21, 1927. The main object in reducing the size of the crates was to make them lighter and thus not only cut down express charges but render practicable their return and re-use.

After the close of the season a movement was started among southern importers to change the season so that quail could be obtained earlier in winter. This, however, does not meet with approval in some of the Northern States, and moreover, would be within open seasons for quail shooting, which do not close in five of the Southern States until after February 1. The distribution of large numbers of high-priced quail before the season closes would seem a doubtful and expensive experiment, and one well-nigh useless unless the birds could be placed on preserves or areas closed to all hunting.

CAGE BIRDS

About one-third of all the known species of parrots have been brought in at various times for purposes of exhibition, and, like canaries, have increased considerably since the World War. Very few parrots breed in captivity in the United States, but some live for a number of years. The number imported annually varies from about 35,000 to 60,000. Of these the largest number are shell parrakeets, or budgerigars, from Australia; and several kinds of Amazons, including Cuban parrots Panama parrots, and double yellowheads from Mexico. Considerable numbers of cockatoos also were brought from Australia, and some of the rarer parrots and parrakeets from the West Indies and South America. One interesting genus of African parrakeet (Agapornis), represented by 10 species, has recently become popular, and at least 8 of the species have been available for aviaries in this country.

The shipment of cage birds from Mexico continues but in reduced numbers. The Mexican Government now requires export permits for cardinals, mocking birds, and certain other species, and before importation permits are issued it is necessary for the importer to obtain not only authority for export from Mexico but authority for possession from the State to which they are consigned. Notwithstanding the restriction of State laws on possession and traffic, applications still continue to be made for the entry of cardinals, mocking birds, and nonpareils.

PROTECTION OF WILD LIFE IN ALASKA

Alaska possesses many interesting and highly valuable forms of wild life that need more protection than is now afforded them through the limited resources available to the Alaska Game Commission. With fairly large numbers of such noted big-game animals as the mountain sheep, the moose, the caribou, the mountain goat, the deer, and the grizzly and Alaska brown bears, and with foxes, beavers, minks, muskrats, and lynxes present in considerable numbers, there exists a real opportunity to put into effect a wild-life administration program that not only will insure a continuance of game and fur animals in present numbers, but should operate to increase the stocks of many of these and of other species, including the marten, which, without better protection, must rapidly go down hill. Forward-looking Alaskans are behind the work of the Alaska Game Commission. Demands are being made for more strict law enforcement than can be given by the commission through its force of seven full-time wardens. Each of these wardens is expected to handle an area of over 70,000 square miles, as compared with only 100 square miles covered by wardens in the better organized States.

Violation of the Alaska game law and regulations is only too frequent because of the small enforcement per-

sonnel now available. During the year the operating expenses of the Alaska Game Commission were more than $67,000. From the sale of licenses and from fines and forfeitures for the same period there was derived $66,000. It is a certainty that the Alaska Game Commission can not fully redeem its responsibility or with success carry out its game and fur conservation and protection program without more funds with which to increase its force of wardens and to provide more adequate transportation facilities for them, particularly boats of a kind that can be kept continuously in service under adverse weather and sea conditions. At present the boats of the commission have to be laid up part of the year because of insufficient operating funds.

Most of the governmental agencies in Alaska do not have enough field work in the winter season and their boats are laid up. Not so, however, with the Alaska Game Commission. The trapping seasons are on from November to March, and it is essential that the wardens be in the field at a time when without suitable boats they are confronted by grave danger in the adverse weather conditions that they are certain to encounter.

The regulations adopted by the Secretary under the Alaska game law of January 13, 1925, already have shown their effectiveness in the conservation of the wild-life resources of the Territory. A popular presentation of the improvement in wild-life conditions there was the basis of an article prepared in the bureau and published in the 1927 Yearbook. Only such changes in the original regulations have been adopted from year to year as investigations have shown to be necessary. The regulations this year were published in Circulars Nos. 4 and 5 of the Alaska Game Commission. Enforcement of the new law and the regulations of the Secretary are under the immediate jurisdiction of the five commissioners authorized by the act, one of whom, the administrative officer, is the chief representative of the Bureau of Biological Survey resident in the Territory.

The amendments adopted this year affect moose, caribou, mountain sheep, and bears. The relative scarcity of moose on the small section of the Alaska Peninsula inhabited by them made it appear advisable to close the season in that region until such time as this animal shows a satisfactory increase. Large brown and grizzly bears also were afforded additional protection on the Kenai and Alaska Peninsulas and in the Kodiak-Afognak Islands group by a reduction in the bag limit from 3 to 2 a season. The limit allowed nonresidents on caribou and mountain sheep was reduced from 3 to 2 each a season. Other amendments affecting big game relate to the handling of the meat of such animals in cooked form in certain portions of the Territory under permit of the Alaska Game Commission.

Last year the regulations provided short open seasons on beaver in certain regions and prescribed a system of tagging the skins of these animals, whether taken within or coming from outside the Territory. This year the season was again closed throughout the Territory, and it is contemplated that the tagging system will be of great assistance in protecting beavers much more effectively. Beaver poaching was formerly a common practice in many sections of Alaska, but owing to the limited force at the disposal of the commission, strict enforcement of the law and regulations proved impossible. Under the tagging system now in effect untagged skins will be subject to seizure.

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